SECTION-4

4.01 — 4.99

NAVIGATIONAL AIDS

NAVIGATIONAL AIDS
SUMMARY

Navigational aids, which are TRANSMITTERS of radio beams, are dealt with in this section. Included in this category are terms such as radio beacons, beam transmitters, navigational beams, and radio stations. (Direction Finders, which are also used as aids to navigation are included only under Section 3.)

PURPOSES

There are two primary purposes for navigational aids:

1. To guide ships or aircraft home to their base.
2. To guide aircraft to a bombing target.

INTERPRETATION

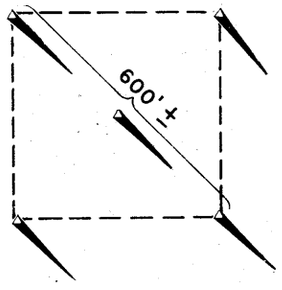
Navigational aids are difficult to interpret from aerial photos, primarily because of the large variety of possible shapes, patterns and sizes such installations may assume.

Although the Germans have standardized certain very high frequency navigational aid equipment (such as the Knickebein), Japanese installations that have been positively identified do not appear to be standardized as to type.

JAPANESE NAVIGATIONAL AIDS

1. RADIO RANGE STATIONS FOR AIRCRAFT

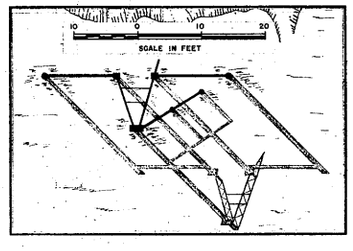
These stations operate normally at between 100 and 300 Kcs. and require no equipment in the plane other than the usual radio receiver. From them one or several beams may be directed to any point of the compass. Reliable distance range would be from 200 to 400 miles.



5 MASTS 200' ± HIGH

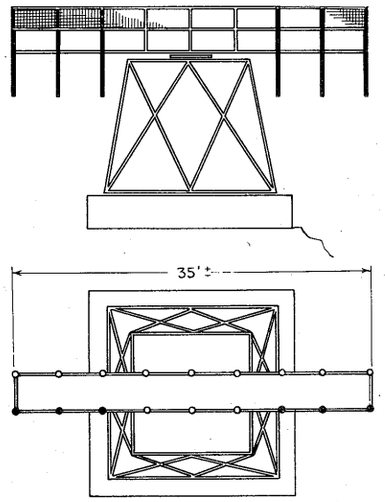
2. KISKA NAVIGATIONAL AID FOR SHIPS

This installation, the only one of its kind found to date, is apparently a makeshift arrangement and is of poor design. It operates at 60 to 70 Mcs. and has effective distance range of approximately 100 miles.



3. CHICHI JIMA NAVIGATIONAL AID FOR SHIPS

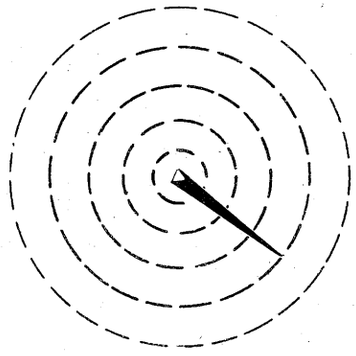
Recently a suspected navigational aid which commands the entrance to the harbour of Chichi Jima, Bonins, has been photographed. If a navigational aid, this installation is probably used for guiding ships at sea.



Note: No other types of Japanese Navigational Aids are known to have been identified from photos (except for communications stations) up to date of publication.

SINGLE RADIATING LATTICE MAST FOR AIRCRAFT

A single radiating mast may serve as an air navigational aid having no directional capacities in itself. Such an installation may send out a beam covering a circular pattern with the mast in the center.



When an aircraft comes within this area of signals, D.F. equipment in the plane itself will home the plane.

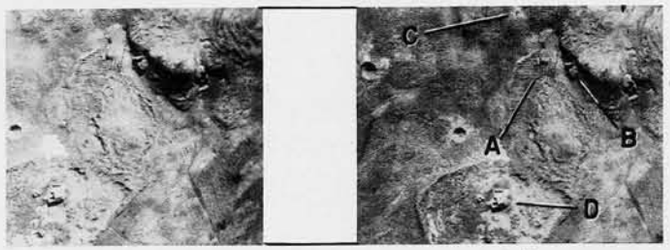
Note: Any single lattice mast is suspected of being an air navigational aid, even though it may not function in the manner shown above.

SIGNALS

Final identification of a Navigational Aid will best be accomplished by checking carefully against any signals that may have been recorded from the area being interpreted-

NAVIGATIONAL AIDS

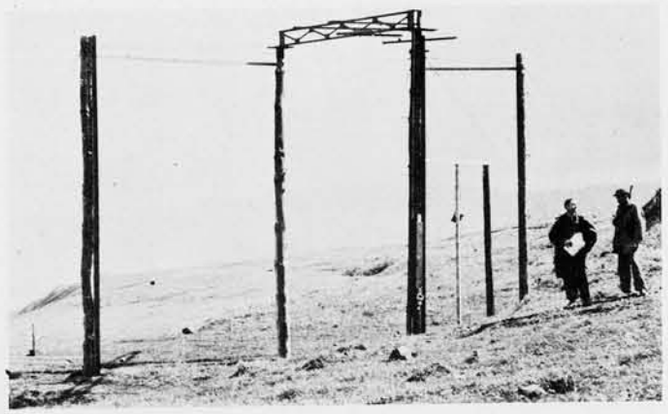
JAPANESE



(R.F. - 1/5200)

KISKA

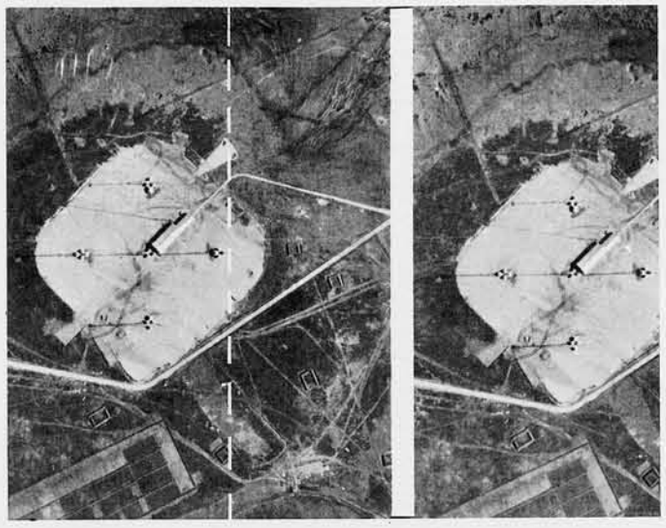
"A" - NAVIGATIONAL AID
"B" - DUGOUT FOR GENERATOR
"C" - MONITOR RECEIVER
"D" - PERSONNEL HUT



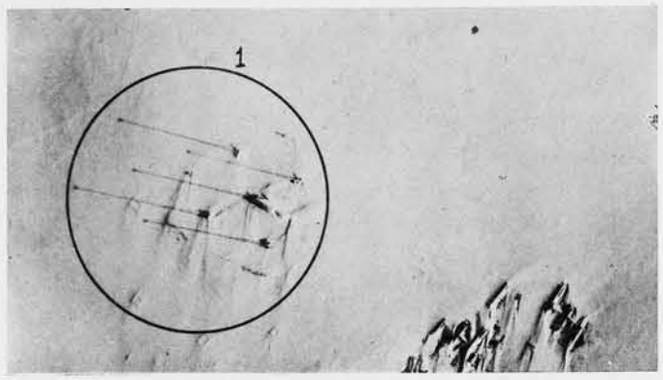
KISKA

The above radio navigational aid, found at South Head, Kiska, was the first Japanese aid captured in this war. Its purpose was to guide ships at sea. This installation is of makeshift nature and is not an efficient electronics device. It is unlikely that the design will be found again. The reflectors are 29 feet long and are set 20 feet above ground level. It operates at a frequency of 70 mcs. Code beam switching, similar in principal to "A and N" is used.

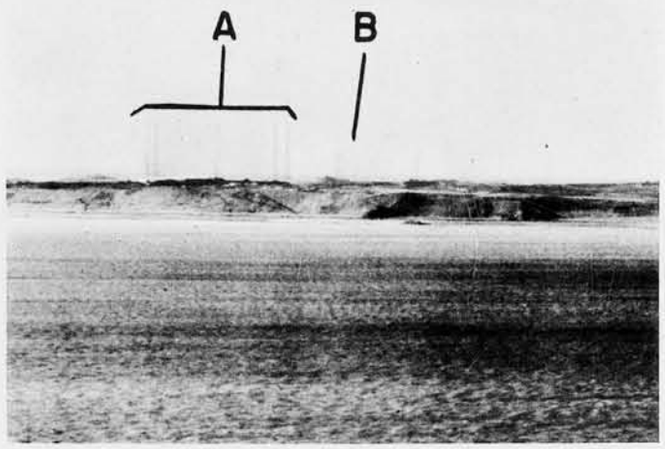
RIGHT: Five mast Radio Range Station at Kurabu Cape, Paramushiro, is very similar to peace time "beam" stations for aircraft. The masts are about 200 feet high and the circular forms at top indicate that they are "top-loading" radiators. The diagonal distance between masts is approximately 600 feet which would indicate frequencies between 200 and 400 Kcs. Radio Range Station.



KURABU CAPE

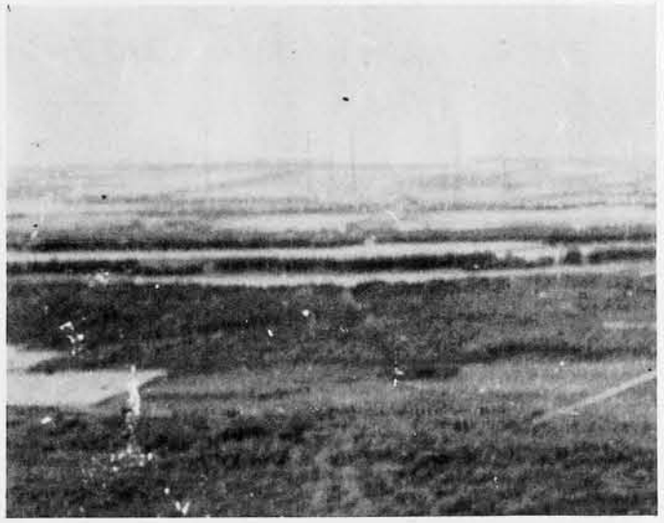


KURABU CAPE



KURABU CAPE

"A" - RADIO RANGE STATION
"B" - MEDIUM FREQUENCY COMMUNICATIONS STATION



TINIAN, MARIANAS

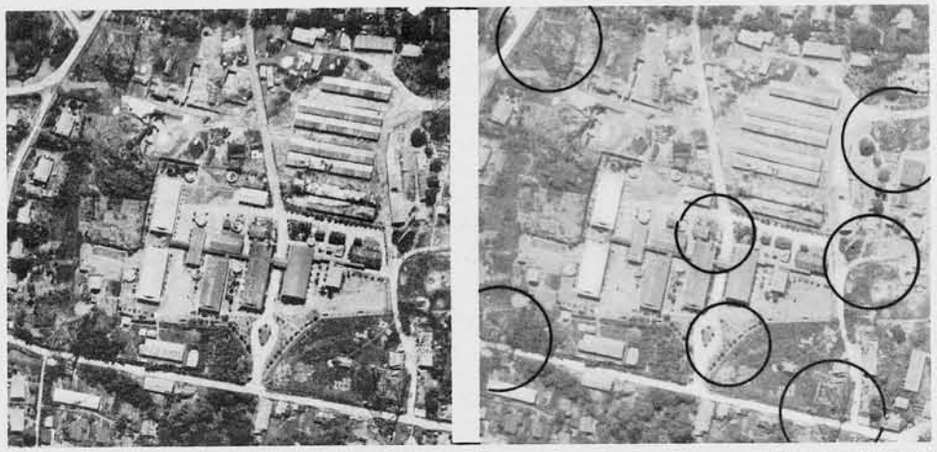
TINIAN

ABOVE: Two views are shown of another Japanese Radio Range Station at Tinian. This pattern of five masts with a diagonal distance of 600 feet is characteristic of Radio Range Stations. This is an air navigational aid.

The advantages of low frequency navigational aids of this type are as follows:

(a) Long range and reliable
(b) No special equipment necessary in plane. Usual radio receiver will act in place of direction finders etc.
(c) May exist from peacetime construction period.

Frequency is usually between 200 and 400 Kcs.



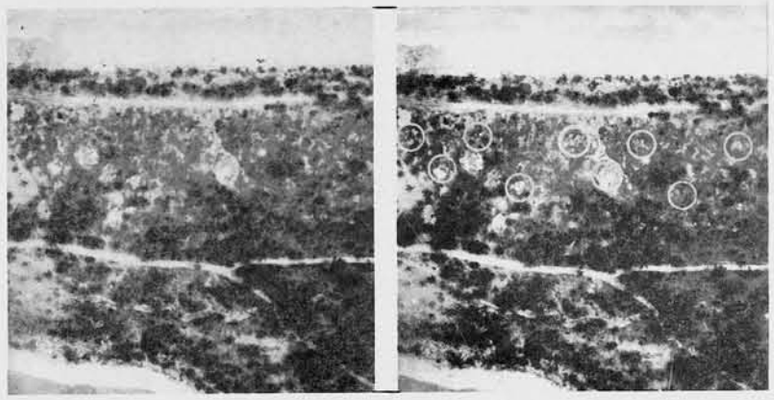
(R.F. - 1/4800)

PALAU

Pre-war Low Frequency Radio Station at Palau which may have facilities for sending a navigational beam for aircraft. The lattice masts are 300 feet high and set in a square pattern with a diagonal distance of 1000 feet.

The stick masts, added recently, are about 100 feet high and are undoubtedly for communications.

There is apparently a small lattice mast in the center of the square pattern of large masts, which would lend support to the thesis that the station could be used for sending a navigational beam.

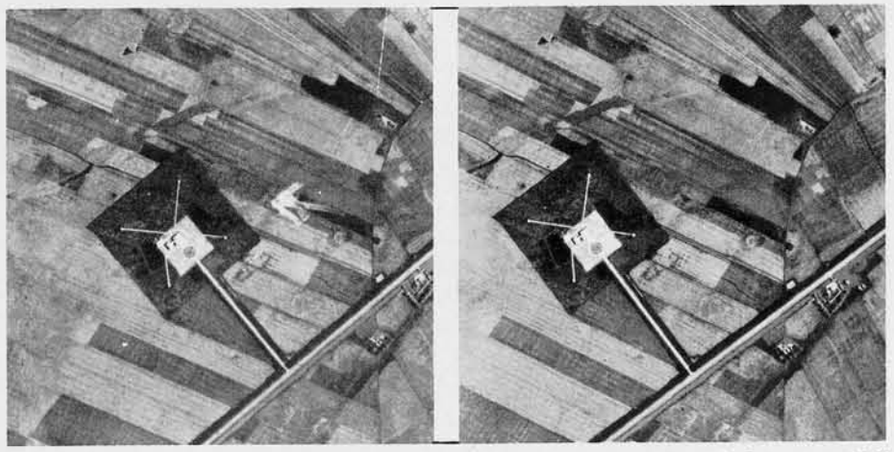


MILLE, MARSHALLS

ABOVE: Stereogram of possible Air Navigational Aid at Mille showing all nine spliced wood stick masts.

A similar mast pattern is also used for directional transmitting and receiving of communications, and it is possible that this may be an intercept station.

A three mast medium frequency communications station is just off the picture to the lower left.

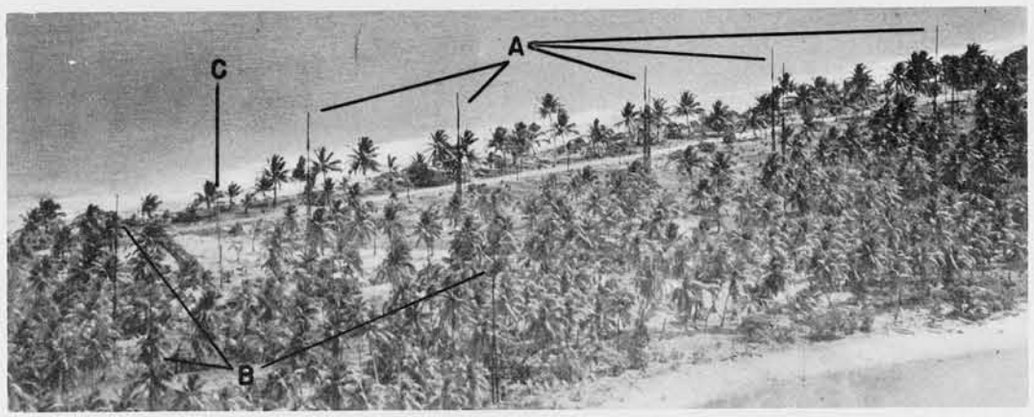


(R.F. - 1/14000)

BANKOK, THAILAND

This installation at Bankok is unusual in that, excepting for size, it looks like a D. F.

However, the masts, which are over 200 feet high, are 5 in number and arranged in a radio range station pattern with a diagonal distance of 600 feet, which would be suitable for sending a beam at frequencies between 200 and 400 Kcs. for guiding aircraft. It is unlikely that D. F. equipment would have such large dimensions, for it would indicate reception of low frequency whereas the need for D. F.'ing on low frequency is slight.



MILLE, MARSHALLS

"A" - 9 STICK MASTS, 75 FEET HIGH
"B" - 3 STICK MASTS, 75 FEET HIGH, FOR COMMUNICATIONS
"C" - POWER OR COMMUNICATIONS LINES

Three views of an unidentified installation on Mille, which is thought to be air navigational aid.

The installation consists of nine type "5" spliced wood stick masts (see page 2.03) arranged in a staggered pattern along the shore.

Note pattern in vertical stereogram. These nine masts are guyed from the top, whereas the communications masts are not.

NAVIGATIONAL AIDS
JAPANESE (CONT.)

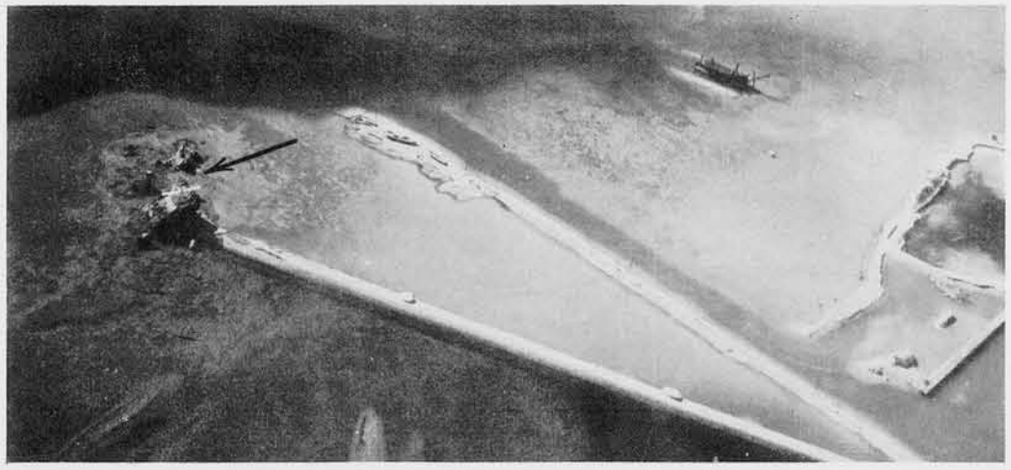
This installation at Chichi Jima is an unusual device which may be used for a Ship Navigational Aid.

It is difficult to delineate its exact construction from these photos, but certain forms seem evident: a long horizontal platform with vertical members (which are assumed to be dipoles) arranged as a fence on a catwalk, but some extending an equal distance below.

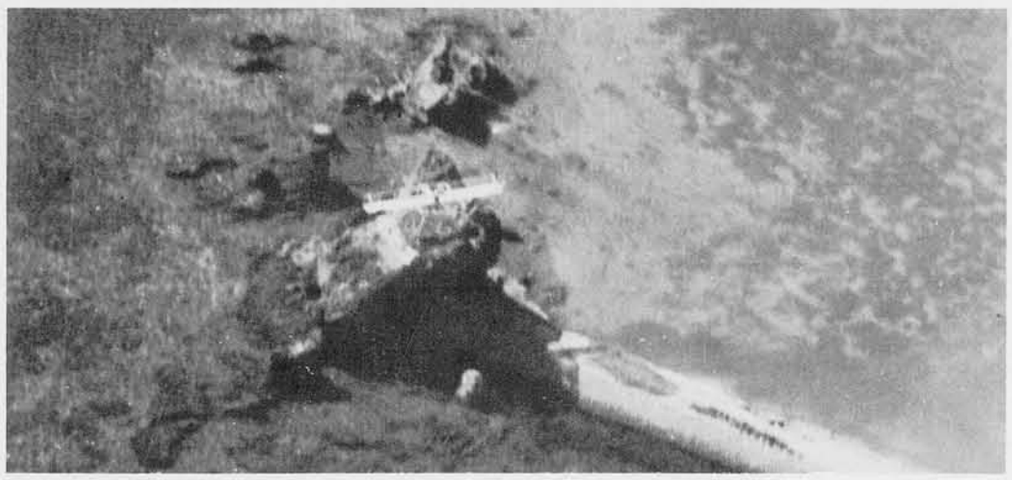
The whole 35 foot horizontal member appears to be capable of rotating on its base. The base, constructed with diagonal cross bracing, is about 15 feet high by 18 feet square in plan view.

The installation is located on the end of a breakwater, so as to command the entrance to the harbor.

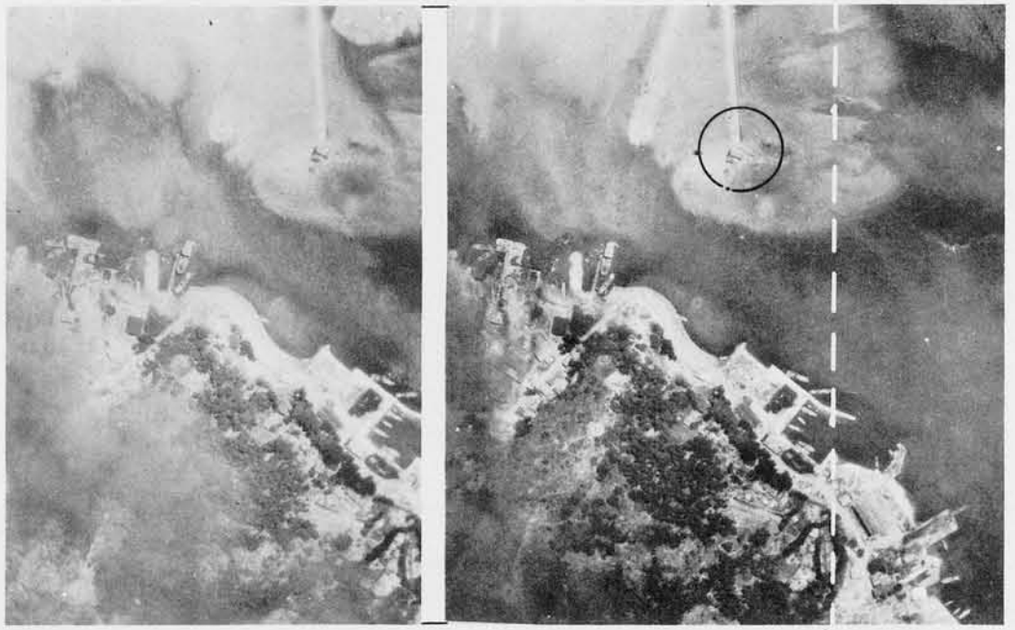
If a Navigational Aid, this installation is undoubtedly for guiding surface vessels and probably operates at high frequencies (30 to 80 Mcs.).



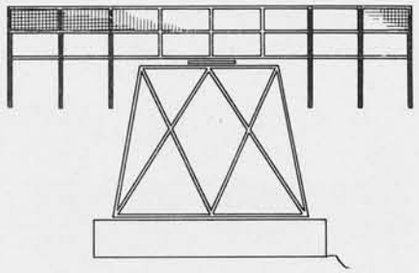
CHICHI JIMA

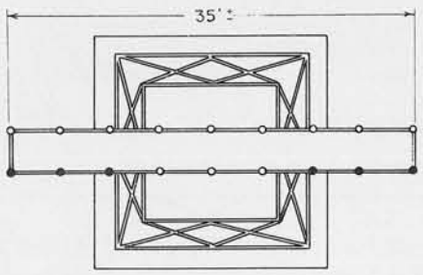


CHICHI JIMA



CHICHI JIMA, BONIN IS.





CHICHI JIMA

NAVIGATIONAL AIDS
SUMMARY (GERMAN)

The Germans have developed several types of Navigational Aids, operating at high frequencies, for homing aircraft and for directing aircraft to bombing objectives.
Below is a table listing the most important standardized types.

In addition to those listed here are Lorenze Stations for homing aircraft, Benito D.F. stations for fighter control, broadcast and radio range stations, portable transmitters dropped near target, ship and submarine navigational beams and others.

FIVE IMPORTANT GERMAN AIR NAVIGATIONAL AIDS

NAME	SIZE OF AERIAL	TOP OF AERIAL ABOVE GROUND	FREQUENCY IN MEGACYCLES PER SECOND	RANGE IN NAUTICAL MILES	USE
KNICKEBEIN	147' WIDE DIAMETER OF TRACK = 98' 20° BEND	50'	30 TO 33.4	215	BLIND BOMBING & NAVIGATION (AZIMUTHAL NAV. BEAM)
RUFFIAN	70' WIDE	30'	66.5 TO 75	215	BLIND BOMBING (AUTOMATIC BOMB RELEASE OVER TARGET - NOW OBSOLETE)
BENITO	50' - 70' WIDE	30'	38.4 TO 45	85-175	BLIND BOMBING (AZIMUTHAL AND RANGING NAV. BEAM FOR BOMBERS & FIGHTERS)
WIND JAMMER	LOWER - 112' WIDE UPPER - 45' WIDE DIAMETER OF TRACK - 56'	82'	38.4 TO 42.3	85	G.C.I. CONTROL OF FIGHTER A/C
ELEKTRA	3 - 300' MASTS 2 MILES APART	300'	0.29 - 0.48	1300	LONG RANGE NAV. BEAM (A/C D.F.'s ON BEAM)

There are no photos shown here of the "Elektra". In lieu of pictures, the following description is given:

The complete installation consists of 3 masts about 300 feet high, laid out in a straight line at regular intervals of 1½ to 2 miles.

The three parts are separate but complimentary. Each mast is accompanied by a small hut adjacent. All three masts and huts are connected by buried cables to the transmitter, which is at or near the central mast.

Elektra is a low frequency fixed installation operating from 0.29 to 0.48 Mcs., and has a range of 1300 nautical miles.

Operation: Aircraft D.F.'s on station to determine which of several equi-signal beams he is on. Beams remain fixed.

Beams remain fixed as to direction, and probably are seldom changed for any given section.

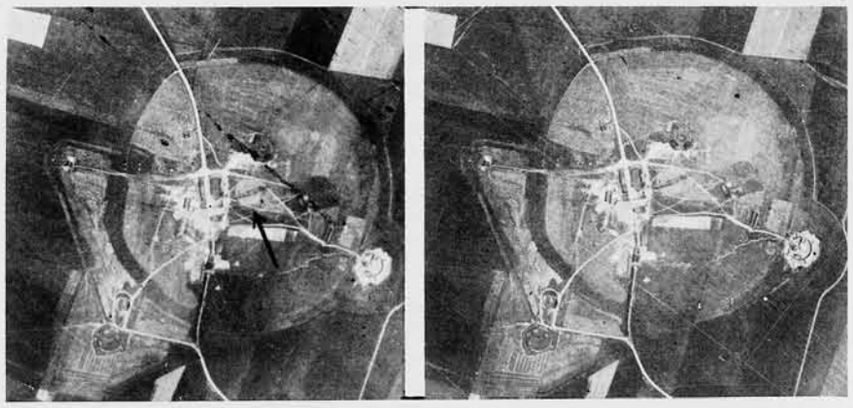
[redacted]

NAVIGATIONAL AIDS
GERMAN

(R.F. - 1/10000)

KNICKEBEIN

The "Knickebein" is probably the best known of the German Navigational Aids. Its name is derived from the pronounced bend in the antennae framework. This bend can be detected by the shadow visible in the above stereogram. The track is 98 feet in diameter.



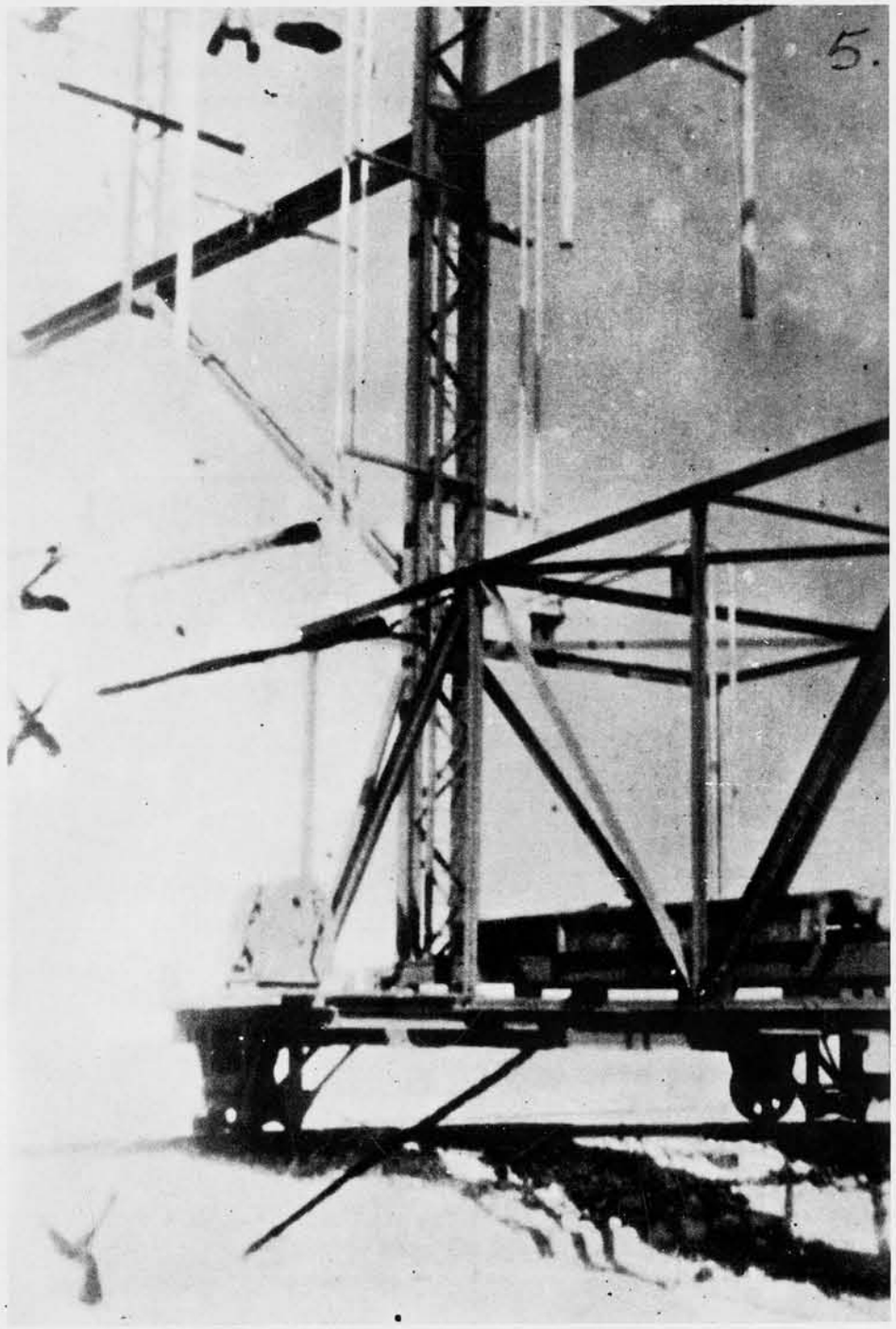
(R.F. - 1/9000)

KNICKEBEIN

The "Knickebein" is an "Azimuthal Navigational Beam" with no provision for ranging. The pilot flies down the beam as in the case of an ordinary beacon or radio range. The frequency band is from 30 to 33.4 mcs.

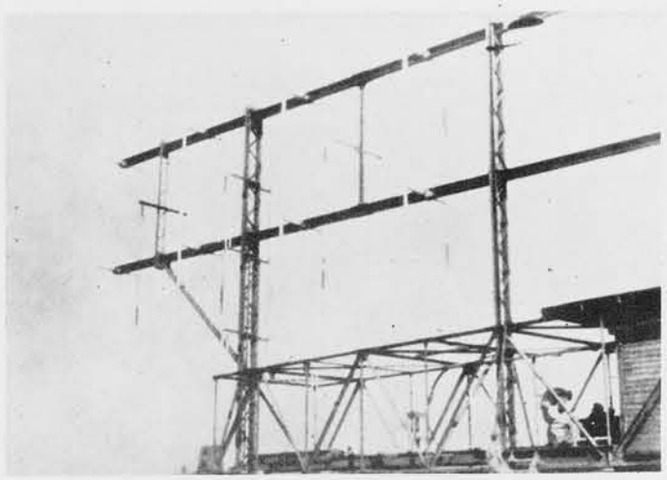
KNICKEBEIN

The above oblique is a well known photo of an early design which is not typical of the standardized form now well known as the "Knickebein".
This heavily constructed installation operates in much the same way as the "Knickebein", however, by transmitting a high frequency azimuthal beam.



KNICKEBEIN

Closeup of antennae shows a series of dipoles, similar to those used with Radar equipment. Track and bogies for rotation of entire instrument are visible here. Cabin is built into framework of aerial and rotates with aerial.



KNICKEBEIN

LEFT: View showing the 4 groups of dipoles and reflectors. Note corner of control shack in lower right.

The only other installation with which the Knickebein might be confused is the "Windjammer".

The Windjammer has no bend in its aerial as has the Knickebein.
The Knickebein has a wider and lower aerial than the Windjammer, and the diameter of the track is greater in the case of the Knickebein.

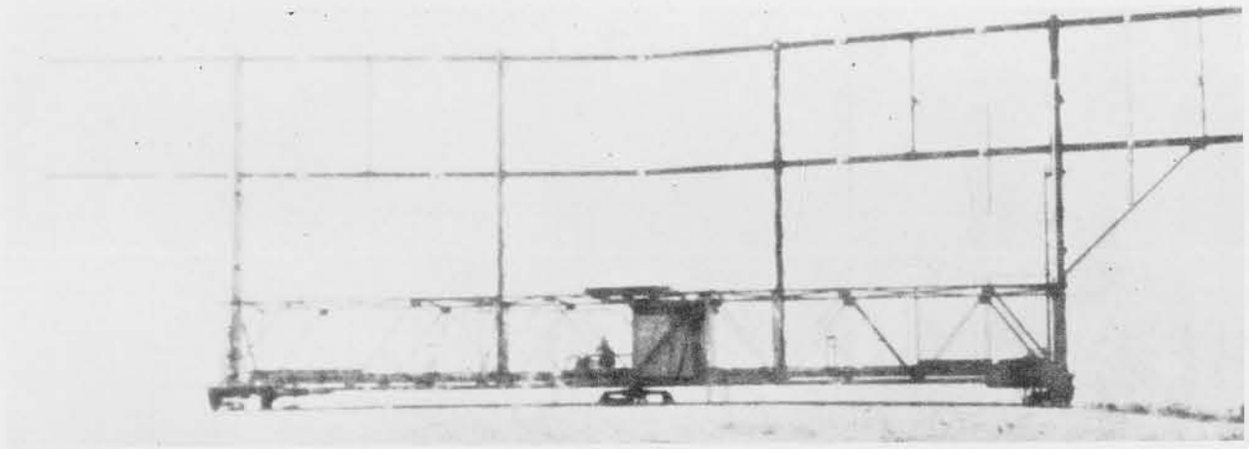
RIGHT: View taken across top of control shack showing center point of bend. There are two sets of four dipoles with reflectors on each side of the bend. The included angle of the bend is 160°.

KNICKEBEIN

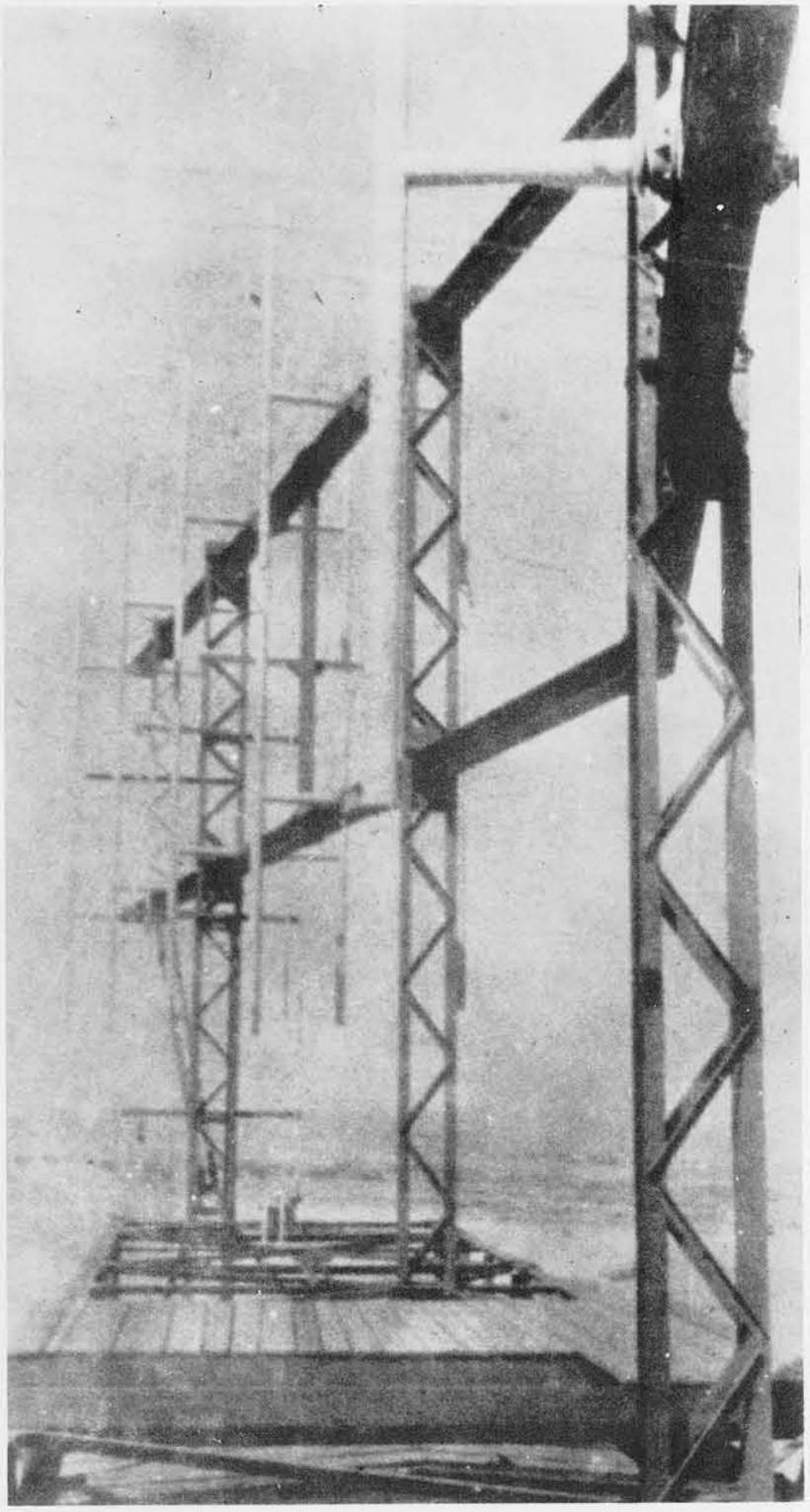
LEFT: Detail of central pivot of turntable. Weight is carried by bogies at ends, which travel on the circular track.
The small cabin is above this point (the Windjammer's cabin extends the full diameter of the track).

BELOW: Comprehensive view of front of "Knickebein".. Aerial is 147 feet wide, track is 98 feet diameter, and the top of the aerial is 50 feet above ground.

Special equipment is necessary in the aircraft. Signal is a dot dash tone and shows on a meter indication.

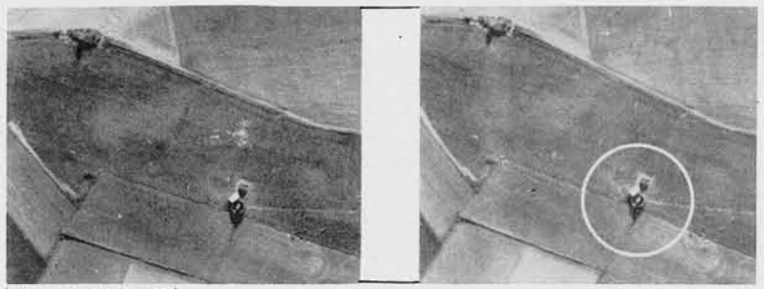


KNICKEBEIN



KNICKEBEIN

NAVIGATIONAL AIDS
GERMAN (CONT.)



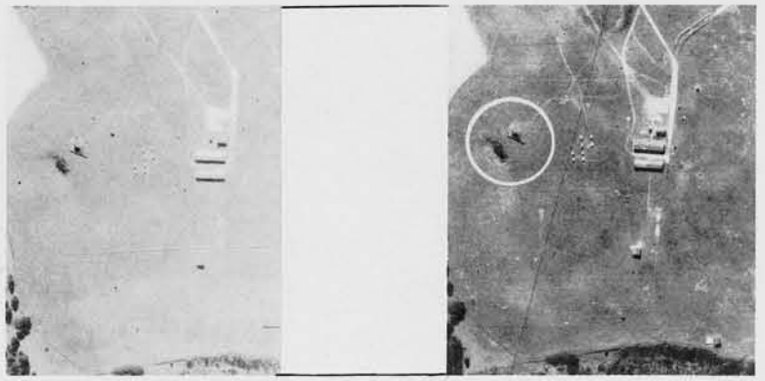
(NO PARALLAX) (R.F. - 1/7500±)

RUFFIAN

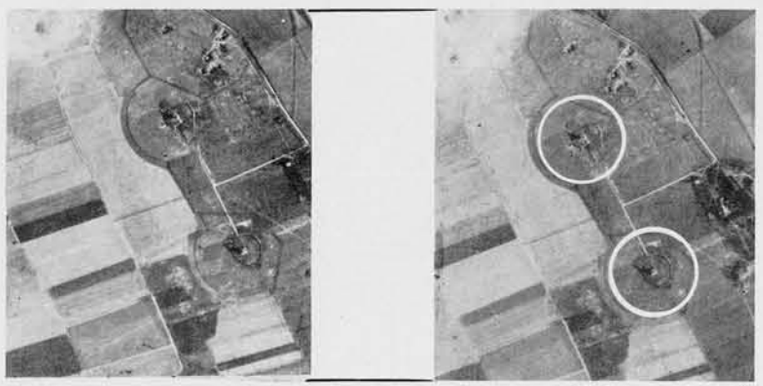
The "Ruffian" is a blind bombing navigational aid which is now obsolete. It employed three sharply defined beams, one over target and two at right angles to target beam. These beams created an automatic bomb release over a specified target (London). Target beam and cross beams were received in aircraft at slightly different frequencies by two different receivers.

Frequencies were between 66.5 to 75 mcs.

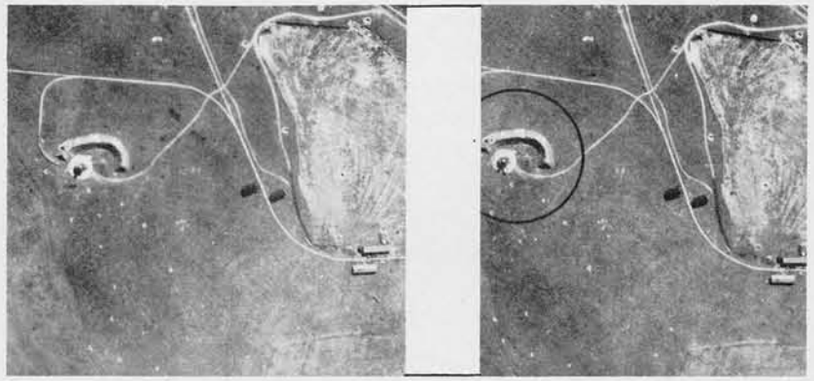
Antenna consisted of a 70 foot cross arm, 30 feet above the ground, with vertical aerials.



BENITO (R.F. - 1/7500±)



BENITO (R.F. - 1/10000±)



(R.F. - 1/7500±)

BENITO

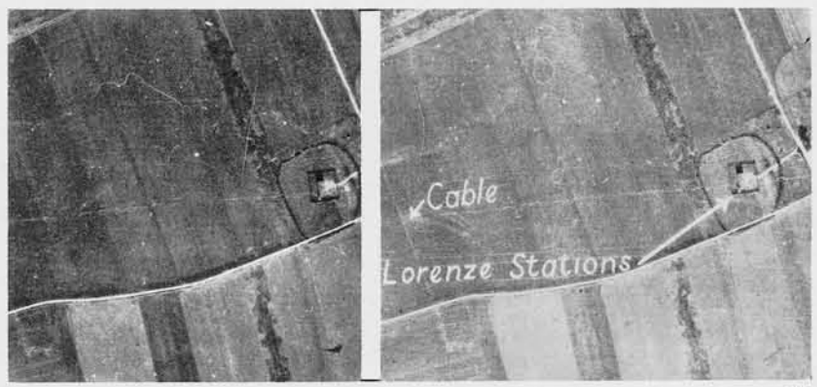
This installation appears to be a navigational aid and resembles a Benito type. Identification is not positive however. The stereogram is included to show the variety of forms such equipment may assume.

LEFT:

The Benito Navigational Aid for bombers is a transmitter of high frequency beams (38.4 to 48 mcs.) and is used for blind bombing giving both range and azimuth.

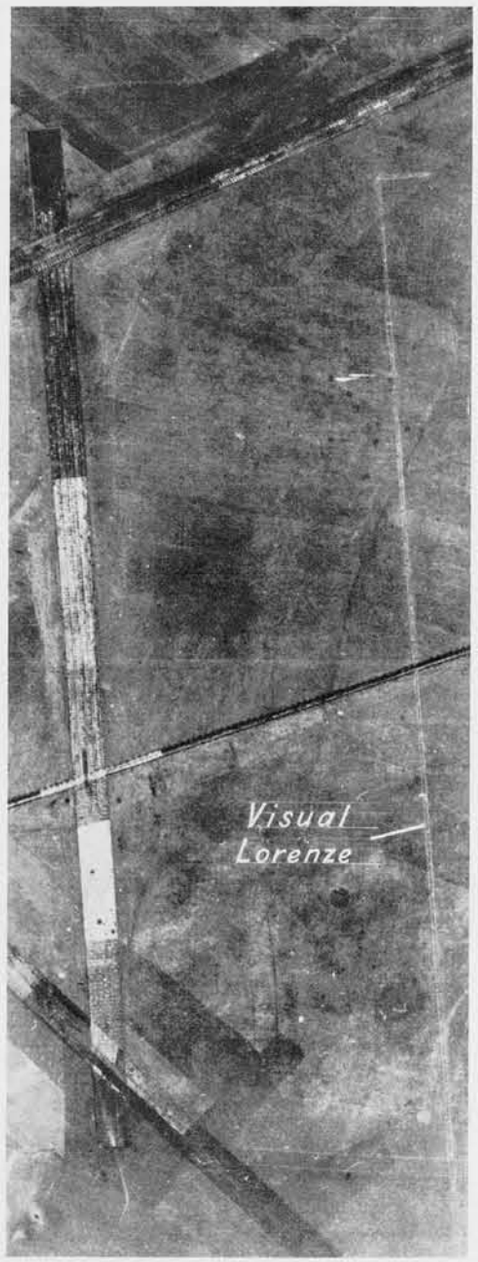
The antenna consists of a rotating cross arm of from 50 to 70 feet supported by "Y" type bracing and containing (in the case of the range antenna) a broadside array of 7 pairs of dipoles with reflectors. Two instruments are needed, one for range and one for azimuth.

The Benito can best be identified from aerial photographs by the shadow of the "Y" type cross arm supports which can be seen clearly in two stereograms shown here.



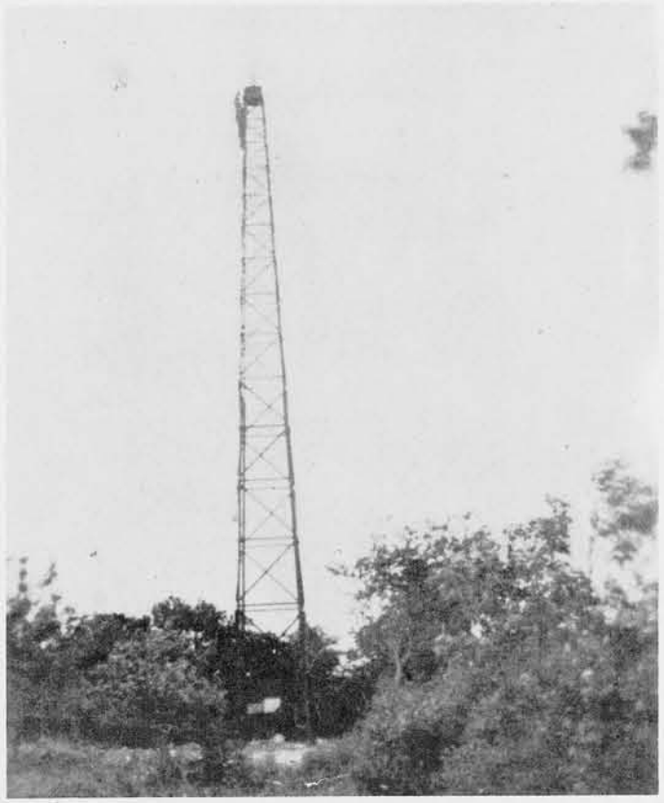
(R.F. - 1/10000±)

VISUAL LORENZE STATIONS



VISUAL LORENZE STATIONS

ABOVE & LEFT: Visual Lorenze Stations are found on or near German airfields. Their purpose is to assist pilots in landing. The extensive white scar pattern created by buried cables is the best identification feature.



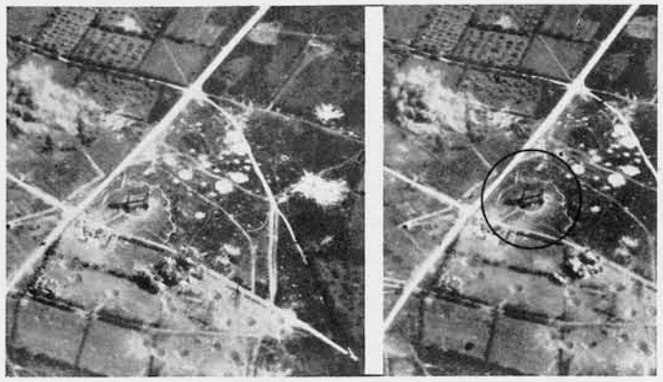
WINDJAMMER MONITOR

On this page are views of the latest German Air Navigational Aid -- the "Windjammer".

The Windjammer is a Radio-Navigational Aid used in connection with German G. C. I. stations in increasing numbers. Its function in fighter control is supplementary to the Giant Wurzburg and it is less subject to jamming. The Windjammer gives slant range and bearing of aircraft.

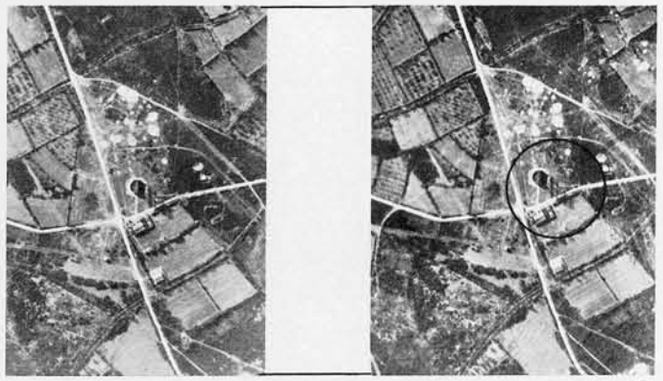
The track is 56 feet in diameter. The widest aerial (the lower aerial) is 112 feet wide. The upper aerial, shaped like a letter basket, is 45 feet wide. Top of aerial assembly is 82 feet above ground.

The elongated cabin, which rotates with the aerial, is divided into three main parts: the central section houses the control gear for the four electric motors, which rotate the structure; the right end (facing the aerial) contains the transmitting equipment; the left end contains work space.

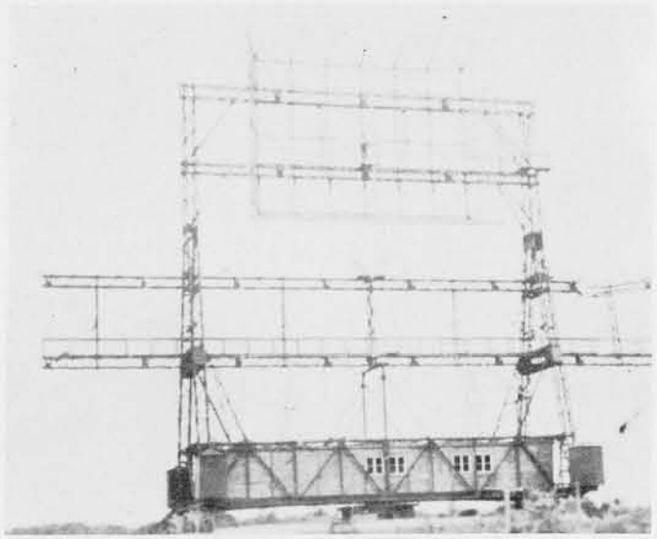


WINDJAMMER

In both of the above stereograms, it is clearly evident that this installation is a Windjammer and not a Knickebein. The lower aerial is 112' x 14' (exclusive projection of the dipoles); the upper aerial is 45' x 30', the top being 82 feet above ground.



WINDJAMMER (R.F. - 1/10000±)



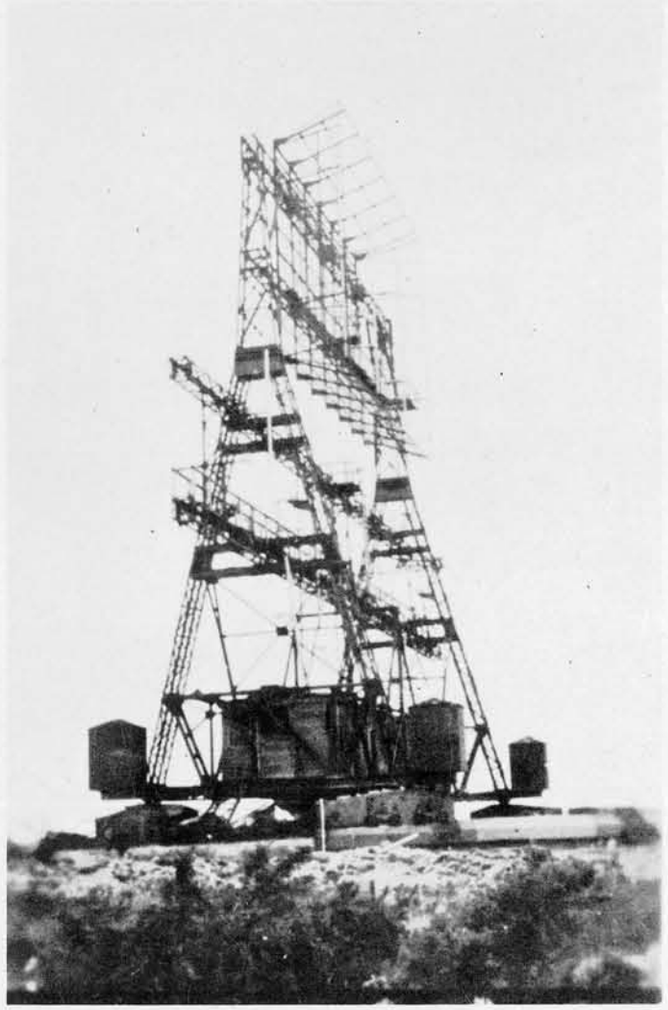
WINDJAMMER

The Windjammer (sometimes called "Benito for Fighters") operates at frequencies between 38.4 and 42.3 Mcs. Its range is about 85 nautical miles for aircraft at 10,000 feet altitude.

The Windjammer installation is accompanied by a Monitor Receiver which is 1/4 mile distant. The monitor consists of a 100 foot high lattice mast surmounted by an 8 foot high aerial (a hollow pipe).

This monitor may also be used for communications with the A/C in connection with G. C. I. control.

An underground cable can usually be seen running from the monitor mast to the Windjammer turntable.



WINDJAMMER

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-5

5.01 — 5.99

ELECTRONICS COMBINATIONS

ELECTRONICS COMBINATIONS

MARCUS ISLAND

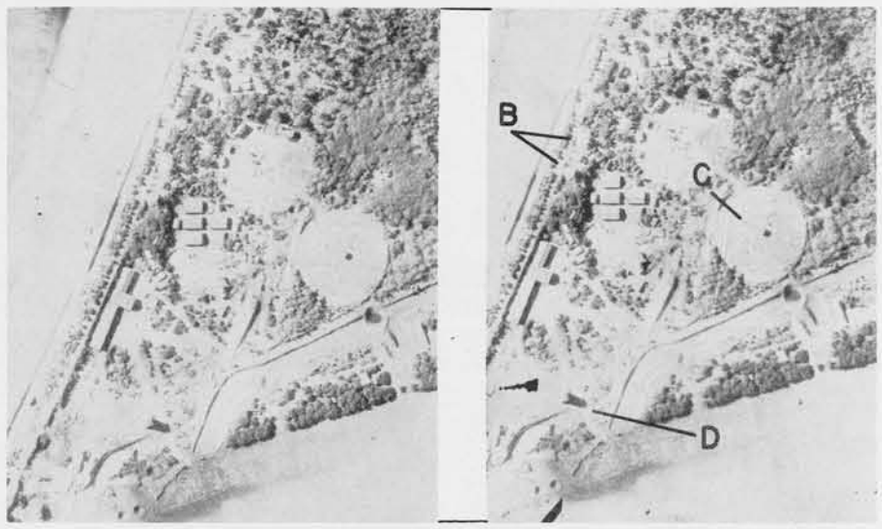
"Electronics Combinations" section is composed of a selected group of Japanese controlled localities which afford particularly good opportunities for studying several types of electronics installations and their relationship to each other.

On Marcus Airfield, shown on this page, can be seen Communications, D.F., and Radar in combination.

(R.F. - 1/9000)

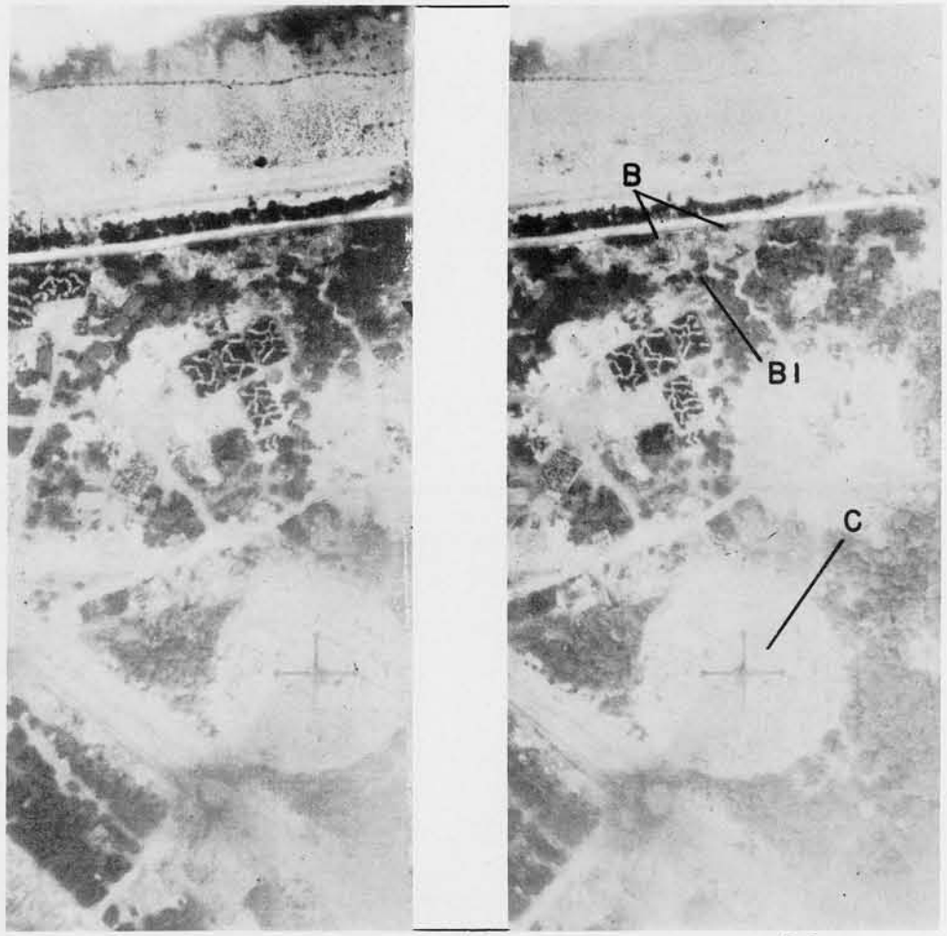
MARCUS

"A" - MEDIUM FREQUENCY COMMUNICATIONS CENTER; "B" - TWO GUADALCANAL TYPE RADARS; "BI" - GENERATOR BUILDING FOR RADARS; "C" - MEDIUM FREQUENCY ADCOCK D.F.: "D" - HIGH FREQUENCY D.F. TOWER.



(R.F. - 1/6700)

MARCUS



(R.F. - 1/3000)

MARCUS

MARCUS

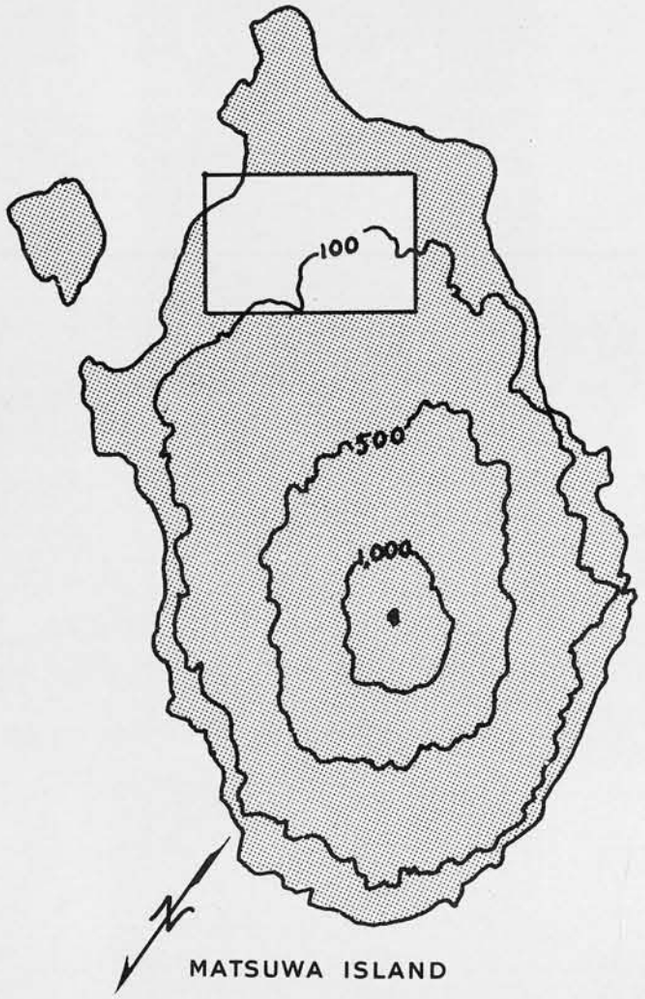
ELECTRONICS COMBINATIONS

MATSUWA ISLAND

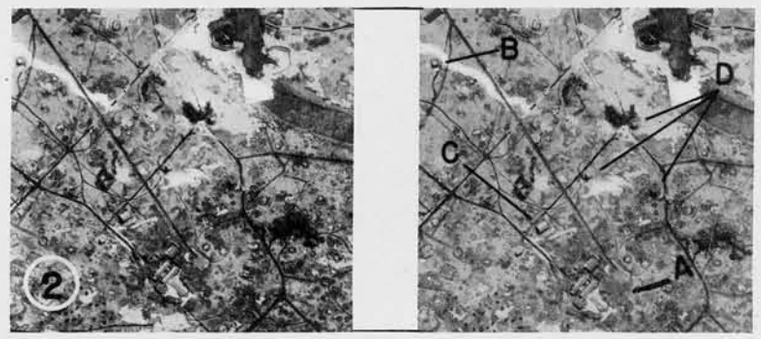
(R.F. - 1/11000)

NORTHERN PORTION OF MATSUWA AIRFIELD

The airfield at the southern tip of Matsuwa contains a fairly complete military electronics system. This set-up is unusual in one respect, however, for it does not include a large communications center with lattice masts, as do most large Japanese airfields. However, Medium and High Frequency stations, using stick masts, are present.



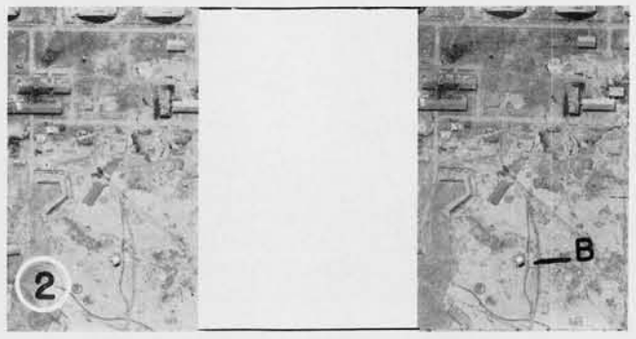
MATSUWA ISLAND



(R.F. - 1/11000)

D. F. CENTER

"A" - D. F. Center Building "B" - High Frequency D. F. Tower
"C" - Probable Generator Building
"D" - Three High Frequency D. F. Towers



(R.F. - 1/7500)

D. F. TOWER

Detail at larger scale of D. F. Tower shown in stereogram to the left. This is probably a High Frequency Adcock.

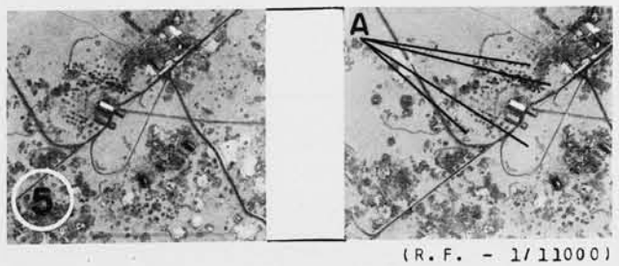
KEY TO INSTALLATIONS:

1. PROBABLE D. F.
2. LARGE D. F. CENTER
3. RADIO WEATHER STATION AND D. F. TOWER
4. RADAR STATION
5. COMMUNICATIONS STATION

CONFIDENTIAL

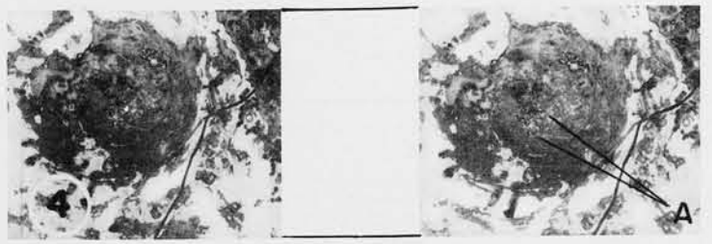
ELECTRONICS COMBINATIONS

MATSUWA ISLAND (CONT.)



(R.F. - 1/11000)

COMMUNICATIONS

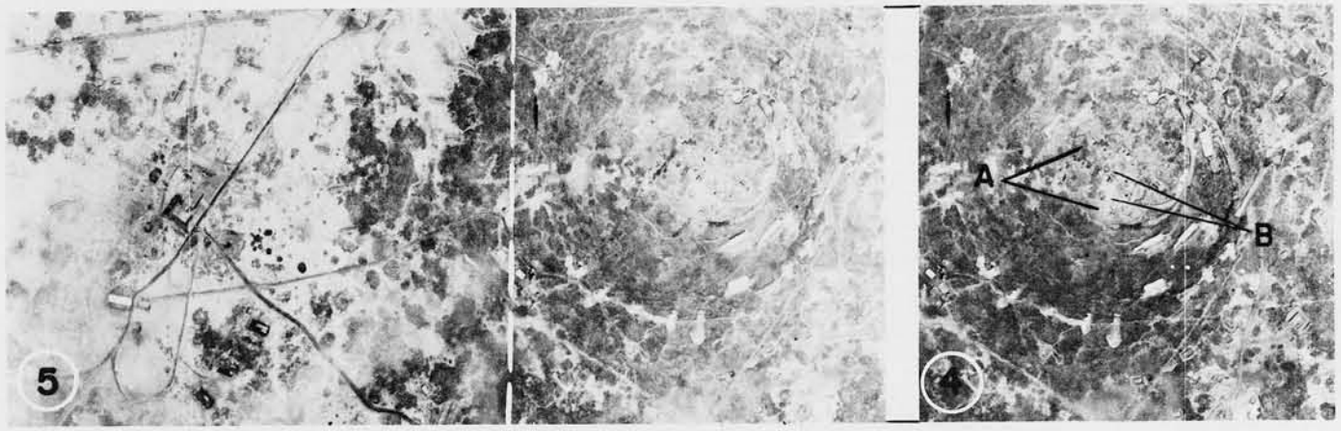


(R.F. - 1/11000)

RADAR STATION

"5-A" - Four of several 75 foot high spliced wood stick masts of Medium Frequency Communications Station.

"4-A" - Two Attu type Radars. It will be noted by comparison with stereogram below, that one of these sets was moved to a new location after this coverage.



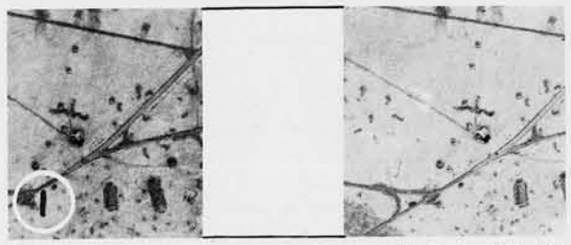
(R.F. - 1/7500)

COMMUNICATIONS AND RADAR

Compare the above installations at each scale. It will be seen that the lower picture (1/7500), which was taken several weeks after the top group, reveals considerable change has taken place at the Radar station. Also note that the smaller scale reveals better detail on the Radio Communications Station than the larger.

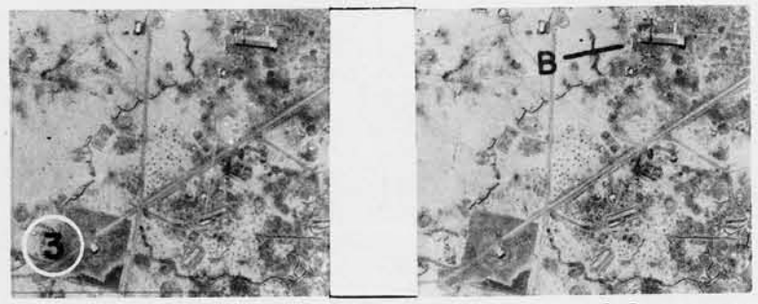
"4-A" - Two Attu Type Radars (siting of one is changed)

"4-B" - Two Mobile Mattress Radars



D.F. TOWER (R.F. - 1/7500)

This tower, situated at the west end of the runway, probably encloses High Frequency D.F. equipment.



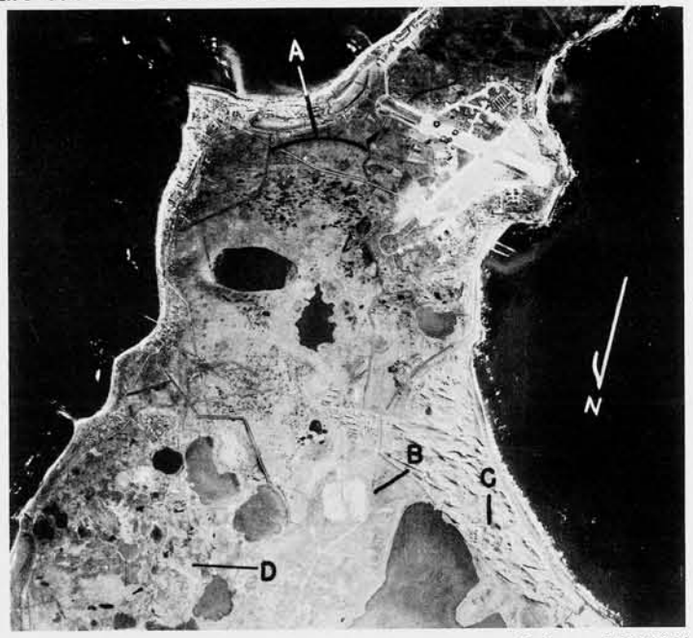
D.F. AND WEATHER STATION (R.F. - 1/7500)

This D.F. tower may enclose a Medium Frequency loop type, similar to Naval D.F.

At the Radio Weather Station (B), the small instrument houses and stick masts for radio are clearly visible.

KURABU CAPE, PARAMUSHIRO

Another airfield, also in the Kuriles, for study of the distribution of various electronics installations.



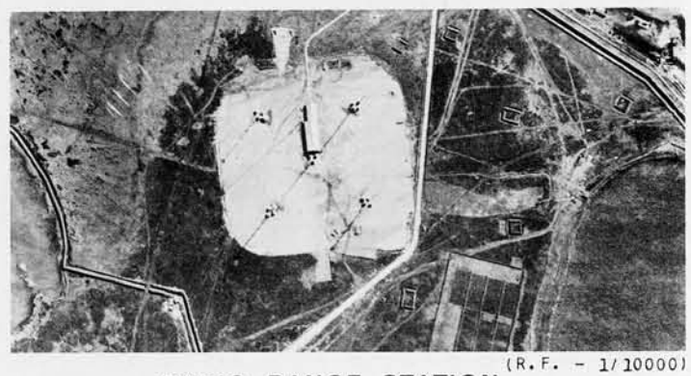
(R.F. - 1/38000)

KURABU CAPE

"A" - D.F. CENTER
"B" - RADIO RANGE STATION
"C" - MEDIUM FREQUENCY COMMUNICATIONS CENTER
"D" - TWO GUADALCANAL TYPE RADARS

(R.F. - 1/10000)

D.F. CENTER



(R.F. - 1/10000)

RADIO RANGE STATION

ELECTRONICS COMBINATIONS

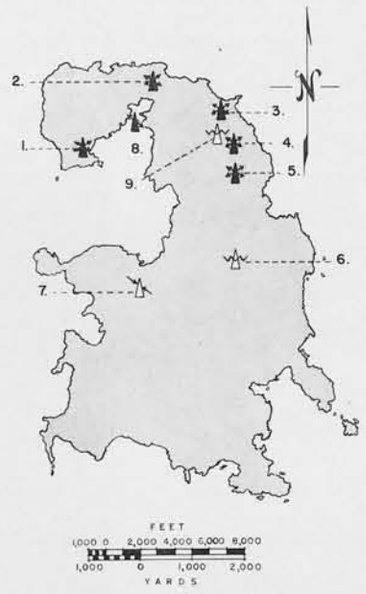
CHICHI JIMA

Chichi Jima, in the Bonins, serves as a good illustration of a small area of Japanese land, well endowed with electronics installations.

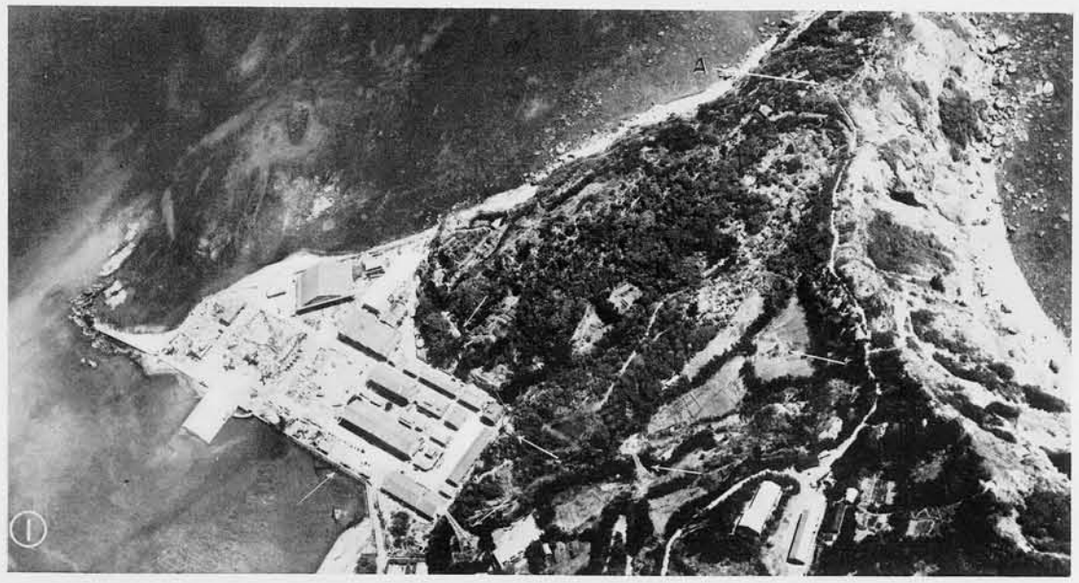
Especially worthy of note is the elaborate development of radio communications, there being five powerful long range stations within an area of two miles square.

In the area covered by these photos, the following Electronics installations have been found: five powerful Communications Stations, operating on medium and low frequencies: two search Radar Stations; one large Direction Finding Center; and one probable Navigational Aid for guiding ships into the harbor.

Numbers on photos are keyed to sketch map at right.

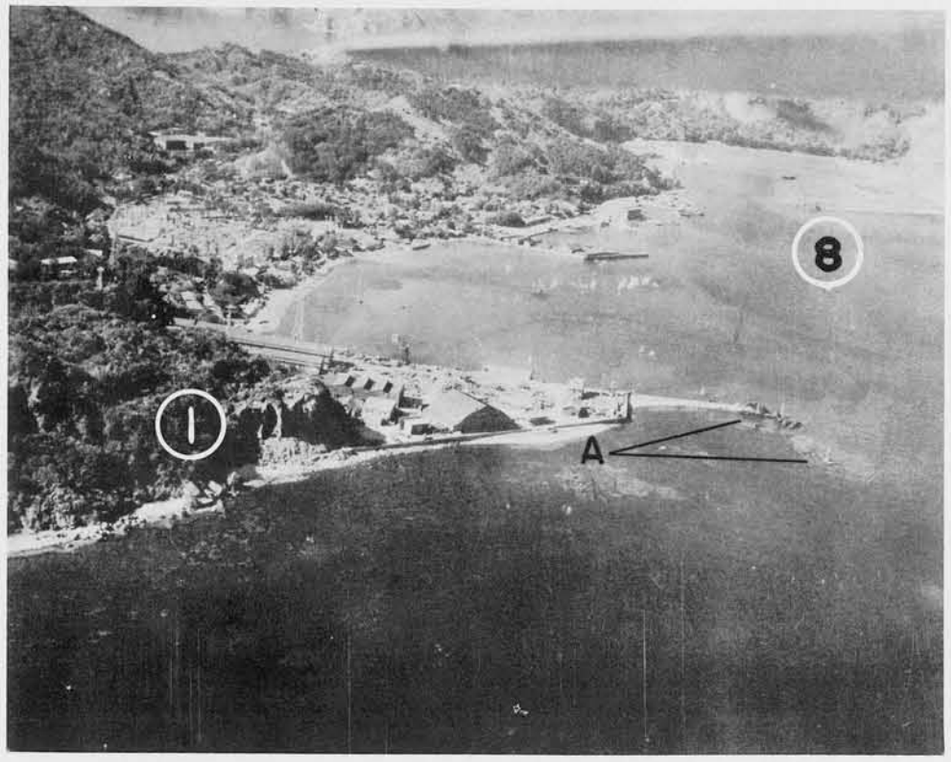


CHICHI JIMA, BONIN IS.



COMMUNICATIONS

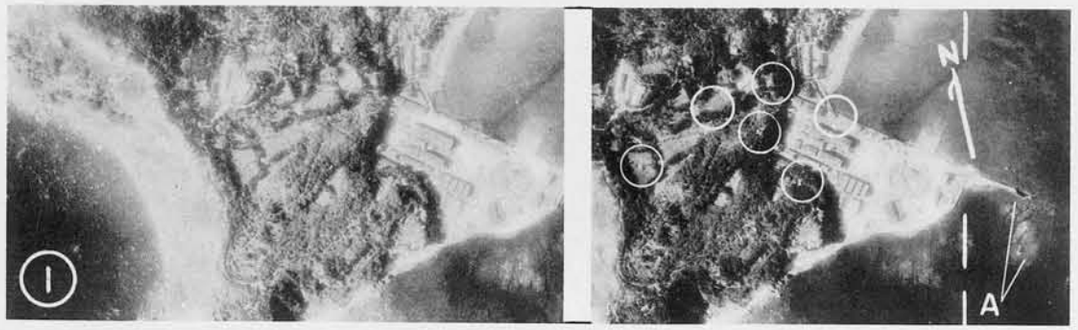
"A" - See page I.27



CHICHI JIMA

Oblique view of harbor showing low frequency station at seaplane base and probable ship navigational aid in background. "A" represents light beacons.

COMMUNICATIONS



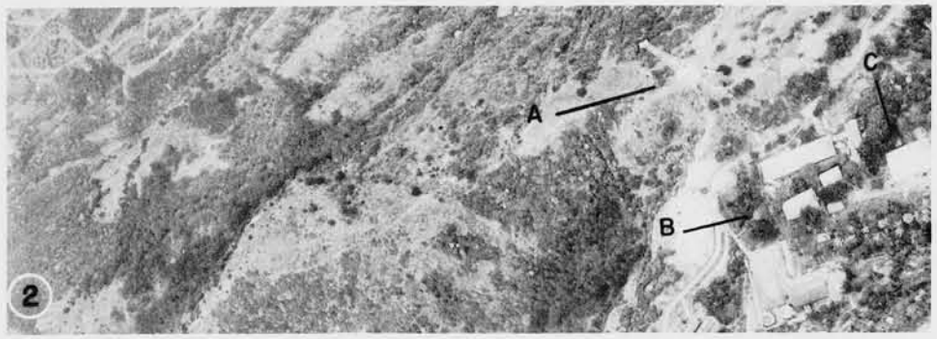
(R.F. - 1/11200)

COMMUNICATIONS

Six mast low frequency communications station at seaplane base. There may be two low frequency transmitters present. "A" - indicates light beacons.

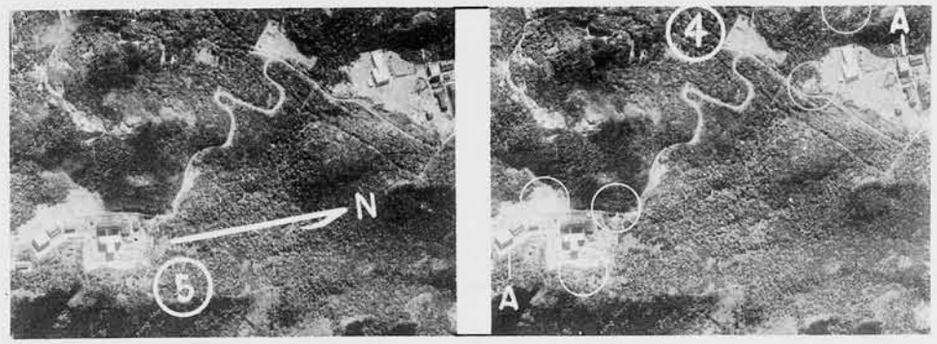
ELECTRONICS COMBINATIONS

CHICHI JIMA (CONT.)



COMMUNICATIONS

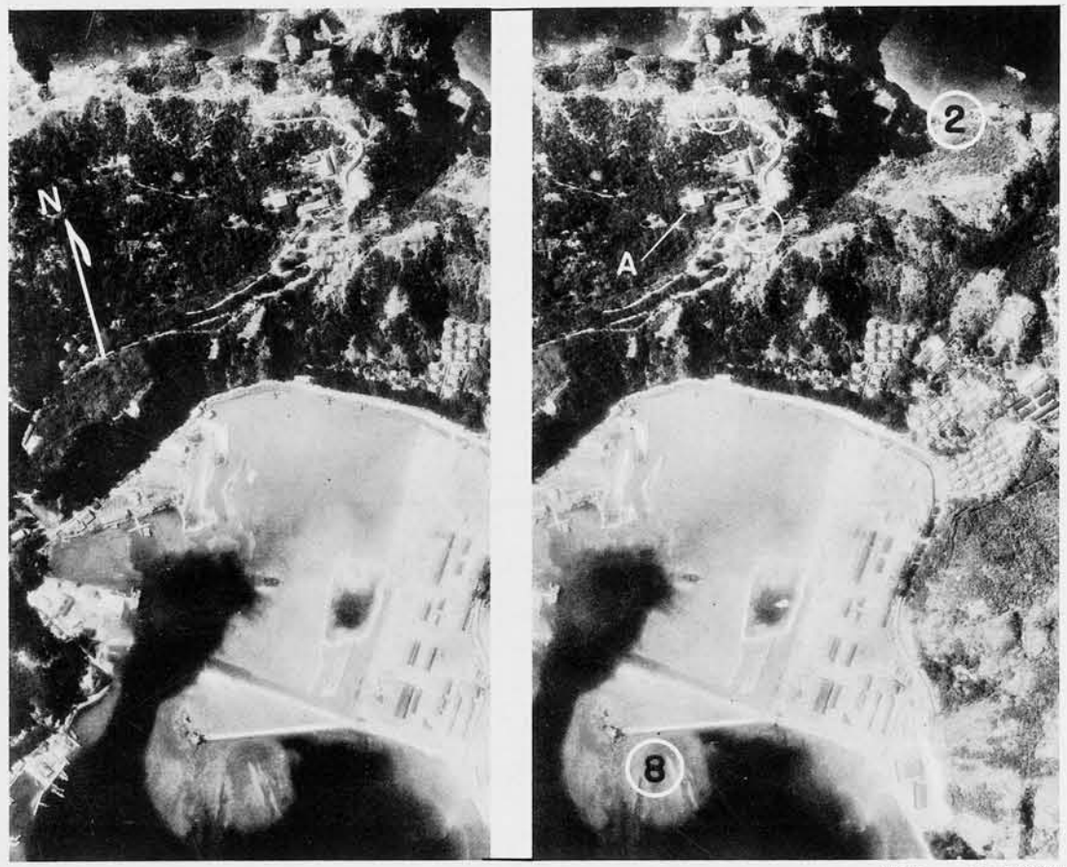
"A" - Low Frequency Lattice mast
"B" - Transmitter building.
"C" - Concrete power plant.



(R.F. - 1/11200)

COMMUNICATIONS

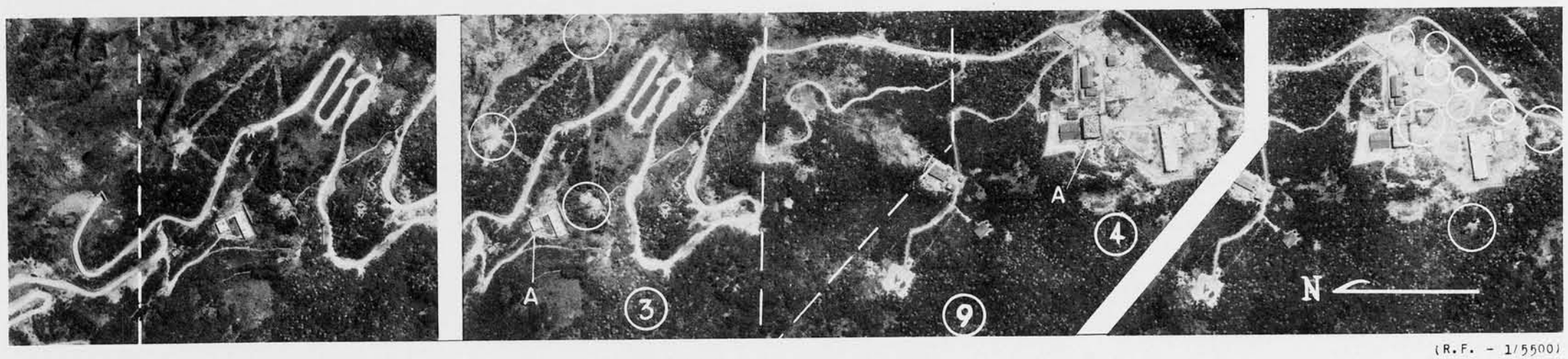
These two communications stations ("4" and "5") are probably medium frequency. The transmitter buildings (white concrete, surrounded by three lattice masts) are but 1800 feet apart. "A" - represents concrete power plant. Stick masts ("4"), indicate multi-frequency (directional?).



(R.F. - 1/11200)

2- COMMUNICATIONS; 8- NAVIGATIONAL AID

Stereogram showing probable ship navigational aid installed at inner end of harbor. Above the harbor is one of the five large communications stations. This is probably low frequency. "A" is concrete power plant. The transmitter building is that building closest to the power plant.

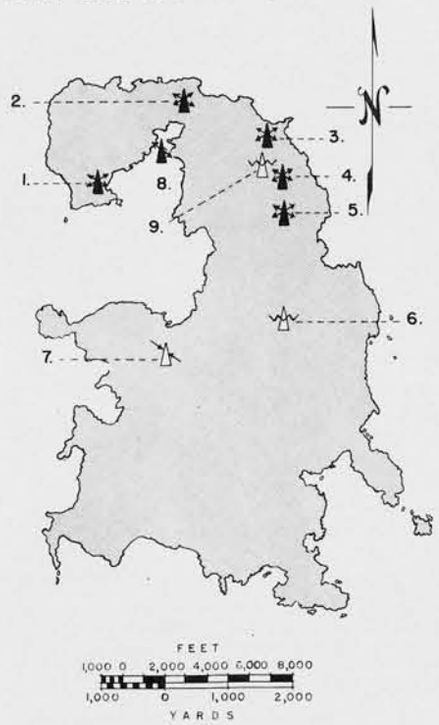


(R.F. - 1/5500)

3 & 4 - COMMUNICATIONS & 9- RADAR

ELECTRONICS COMBINATIONS

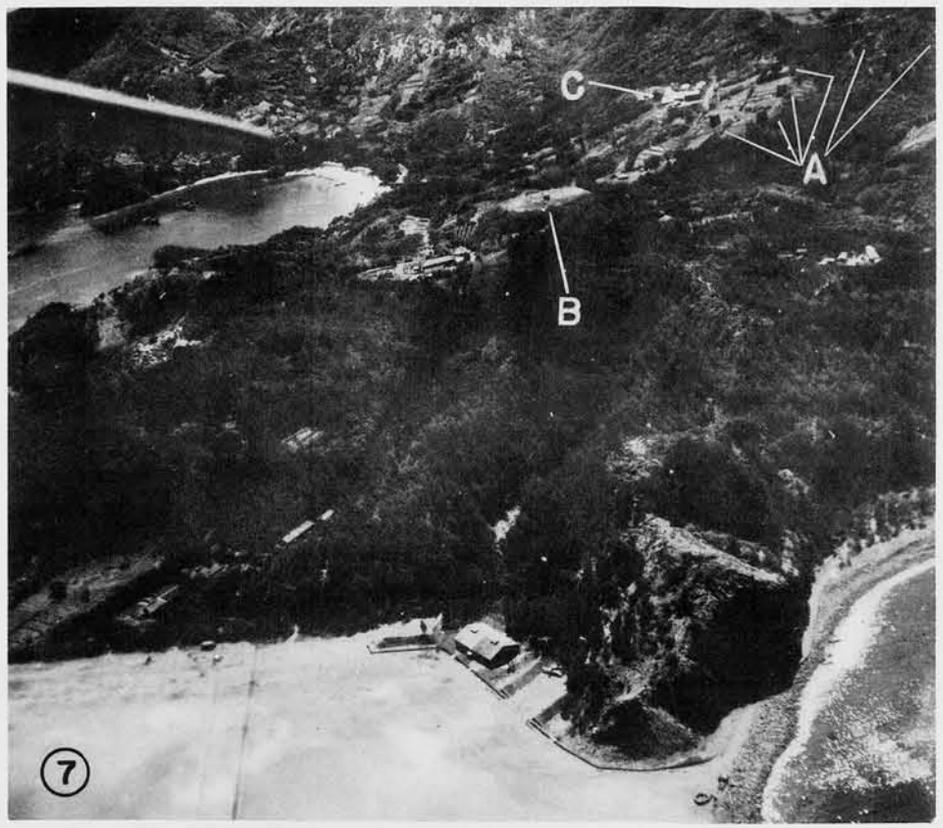
CHICHI JIMA (CONT.)



CHICHI JIMA

On this page are shown some of Chichi Jima's D. F. and Radar installations. The D. F. is adjacent to the airfield which is near the west coast of the island.

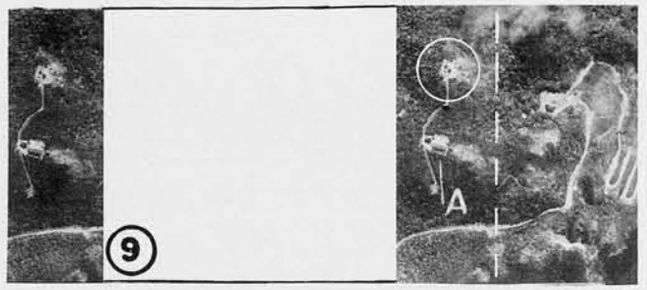
Both Radar sets are mounted on high peaks inland.



DIRECTION FINDING CENTER

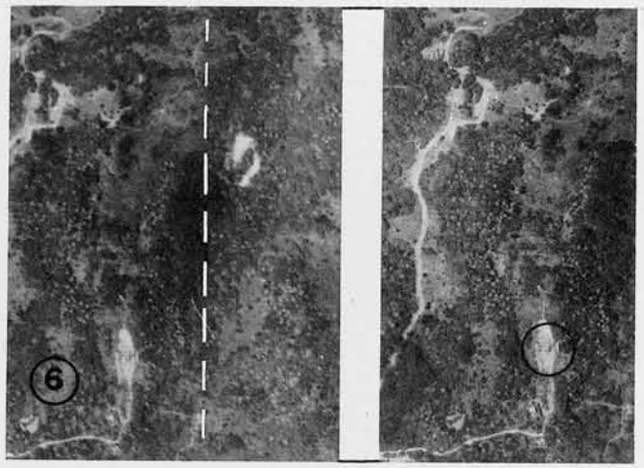
"A" - Six High Frequency D. F. Towers.
"B" - One Medium Frequency Adcock.
"C" - D. F. Center and Reporting Station.

Airfield is located to the right (off the picture). This D. F. center has an unusually large number of High Frequency installations.



(R. F. - 1/11200)

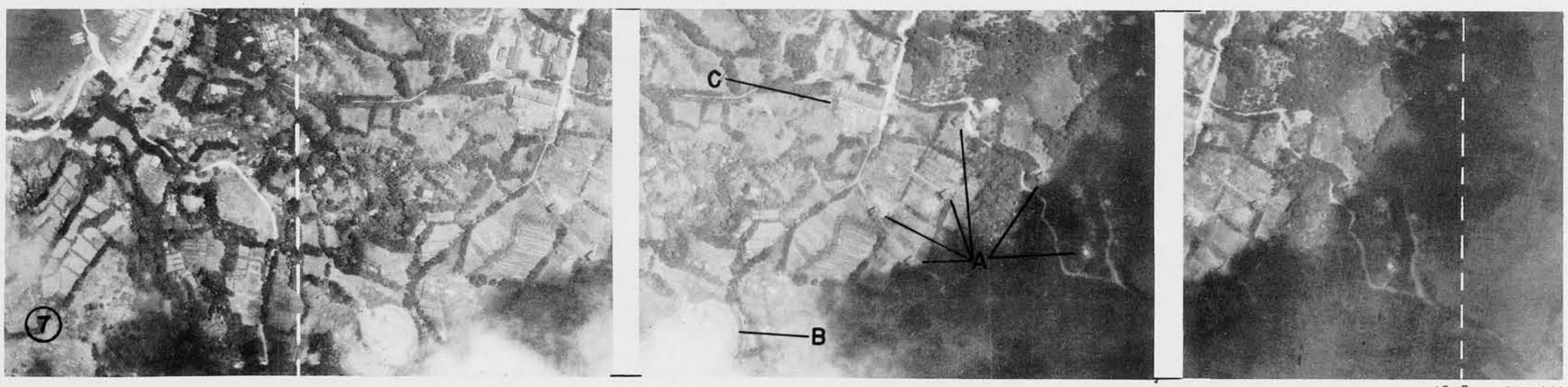
NORTH RADAR STATION



(R. F. - 1/5500)

SOUTH RADAR STATION

"A" - A somewhat standardized building group appears at both Chichi Jima Radar Stations. (Some of the buildings are off photo to lower left in stereogram of south Radar.) Barracks, observation, plotting are probably uses.



(R. F. - 1/5500)

DIRECTION FINDING CENTER

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-6

6.01 — 6.99

RELATED INSTALLATIONS

RELATED INSTALLATIONS

GENERATOR BUILDINGS

"Related Installations" section is composed mainly of reference material on electric power, including power buildings, transformers, transmission lines etc.

The smallest power building types, housing but one Diesel engine and generator, are called "Generator Buildings" (see below). They are used to supply power to some particular military installation. The buildings are usually of wood construction.

The "Military Power Plants" are usually constructed of heavy reinforced concrete and contain two or more Diesel engines and generators. They are nearly always accompanied by a "Water Cooling Tank Building" and an "Oil Storage Building".

These plants supply power to a number of military installations, or to a "Radio Communications Center".

When used with a Communications Center, the generator building itself becomes an integral part of the standard concrete building (which also houses the transmitter, offices, and batteries). The oil and water buildings, however, remain as separate structures.

Several views of "Large Power Stations" show hydro-electric and steam power stations in Japan. Such plants supply power to large industrial areas and to cities. The Japanese have built a great number of hydro-electric plants, which are easily identified on aerial photographs.

In addition to the military power plants and generator buildings shown are several other less used designs as well as the rather common practice of burying the generating equipment or concealing it in a cave.

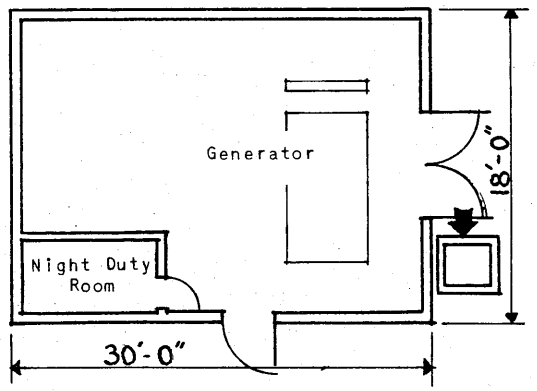
BELOW: Drawings (from captured sketches) of two standard building types which are reported to have been used at Nauru are shown here for reference. These buildings are designed for prefabrication. When built entirely by local contract, these structures may vary in appearance.

In addition to Radar and D.F. generator buildings, the Japanese also use similar prefabricated types for use with anti-aircraft batteries (ground plan 26'x20') and for coastal defense batteries (ground plan 36'x26').

It is thought that the more common design for a D.F. generator building entails the use of buttresses similar to those used on D.F. towers.

ELEVATIONS

PLAN

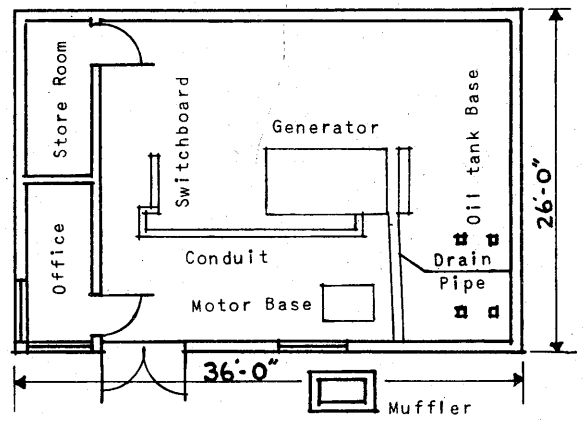


PREFABRICATED GENERATOR BUILDING FOR RADAR. This design was used at Nauru. Building is 18'x30' in plan and is about 9 feet high from ground to eaves. Arrow points to muffler.

GENERATOR BLDG.—RADAR

ELEVATIONS

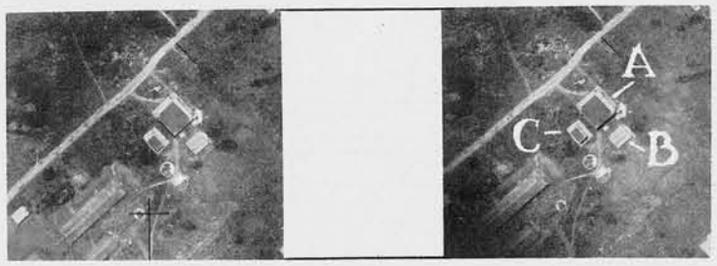
PLAN



PREFABRICATED GENERATOR BUILDING FOR DIRECTION FINDER STATION. This type used at Nauru was 26'x36' in plan and 10 feet high from ground to eaves. (This building may be higher and have buttresses).

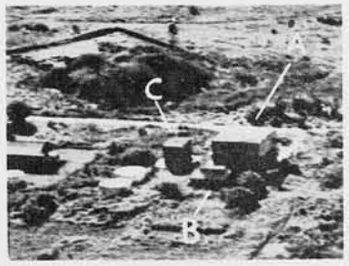
GENERATOR BLDG. — D.F.

RELATED INSTALLATIONS
MILITARY POWER PLANTS

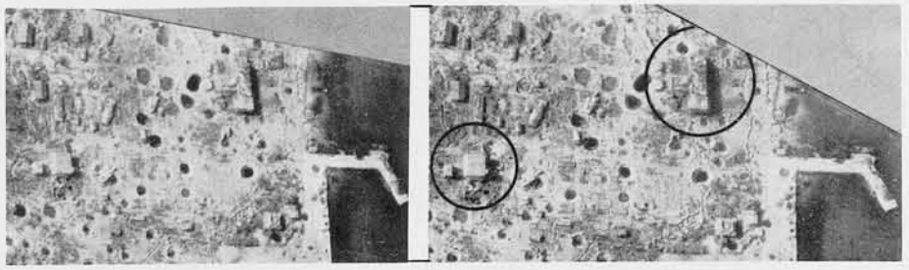


(R.F. - 1/4800)

POWER PLANT GROUP - SAIPAN

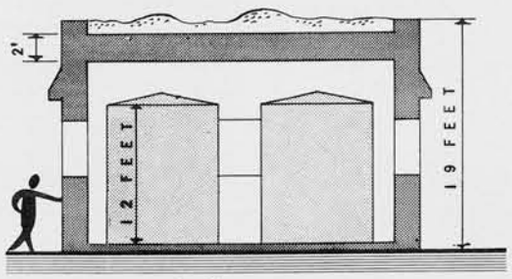


SAIPAN

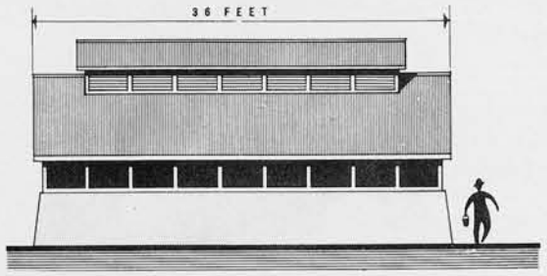


(R.F. - 1/5000)

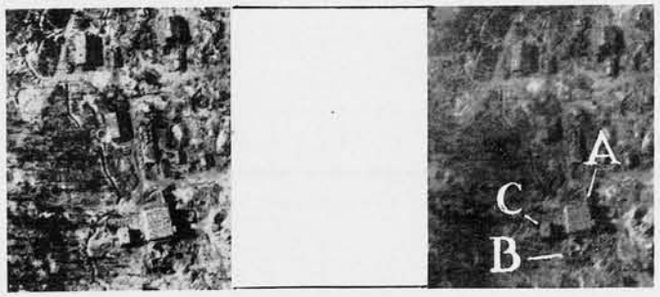
JALUIT



SECTION



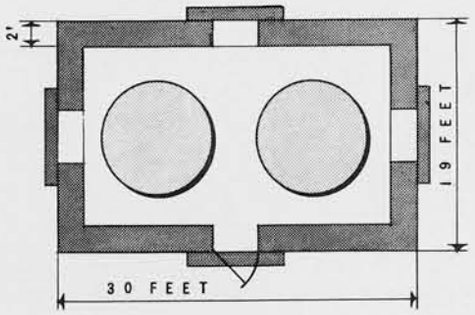
ELEVATION



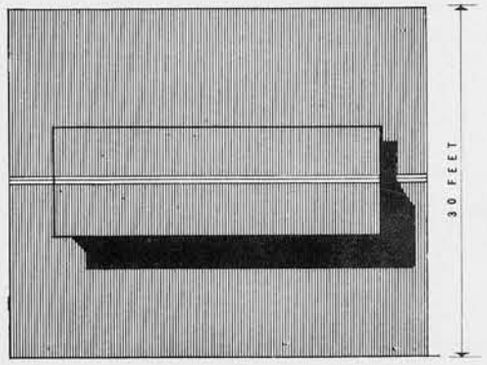
(R.F. - 1/4000)

JALUIT

PLAN

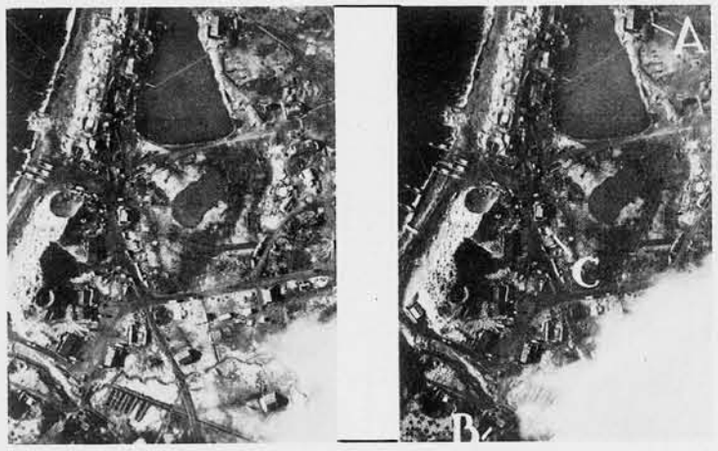


OIL STORAGE BLDG.



ROOF PLAN

WATER COOLING BLDG.



KISKA (R.F. - 1/6200)

KISKA (R.F. - 1/3000)

Japanese power plant groups such as those shown above are fairly well standardized throughout the island areas. They consist of the following:

"A" - CONCRETE GENERATOR BUILDING 48' x55' x22' HIGH
"B" - WATER COOLING TANK BUILDING 18' x28'
"C" - CONCRETE OIL STORAGE BUILDING 19' x30' x19' HIGH

The Water Cooling Tank building is merely covering for the tanks. The structure is of wood with a monitor roof, the top of which is 15 feet above ground. The Oil Storage building is heavy concrete with a flat roof, sometimes covered with earth.

The top stereogram of Jaluit shows a Power Plant Group on the left, and a concrete Communications Center on the right, which contains its own power plant.

FAR LEFT: Two revetted wooden power plant buildings in the Aleutians.

"A" - NORTHERN POWER PLANT 35' x55'
"B" - SOUTHERN POWER PLANT 35' x35'
"C" - RADIO STATION

Note oil storage near Northern power plant. This type of power plant is not as typical at the present time as the ones shown above. These are quite vulnerable to bombing attack.

LEFT: Northern power plant reconstructed and enlarged after original was damaged by U. S. bombing.

CONFIDENTIAL

RELATED INSTALLATIONS
MILITARY POWER PLANTS (CONT.)

MALOELAP

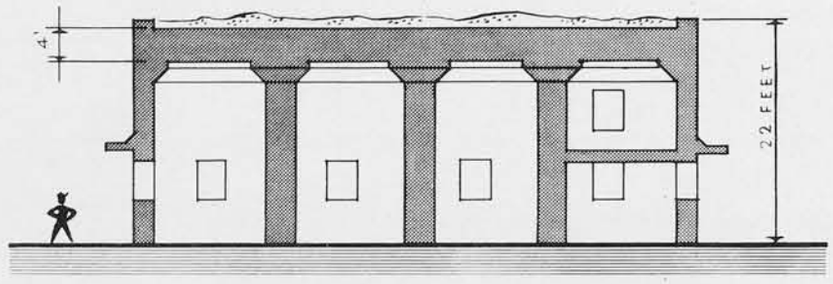
"A" - 48' x55' CONCRETE POWER PLANT
"B" - WATER COOLING TANK BUILDING
"C" - CONCRETE OIL STORAGE BUILDING

DIESEL GENERATOR

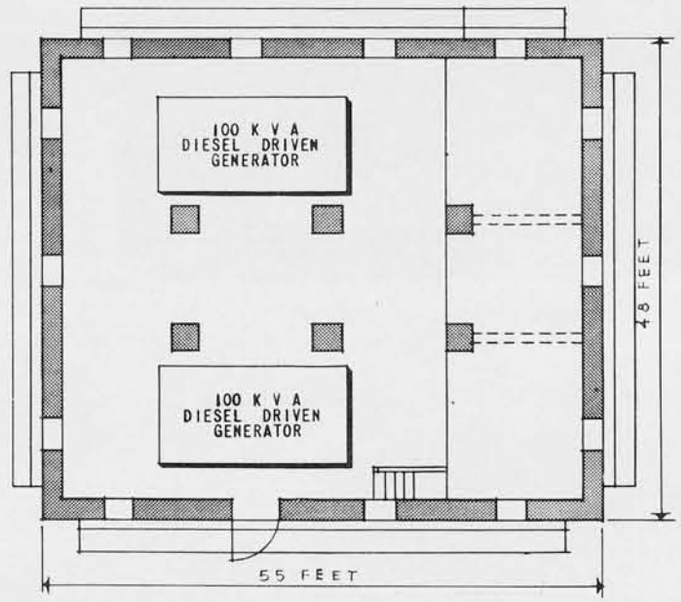
This type of engine (also example below, left) stands about ten feet high when set on its mountings, and thus requires a high ceiling in buildings where installed.

DIESEL GENERATOR

KWAJALEIN



SECTION



CONCRETE POWER PLANT

Standard concrete Power Plant building. The dimensions are 48' x55' x22' high. These structures are very strongly built, having walls 2' thick and roof 4' thick, covered by earth which is filled to the level of the tops of the parapets. Vents are usually visible in roof. Six heavy (4' square) reinforced concrete columns are used to support the roof slab.

There are other types of concrete Military Power Plants in use by the Japanese. However, this design is shown because it has been seen most often up to the present date.

Two examples of large Diesel engines with generators of the type used in Military power plants are shown on this page.

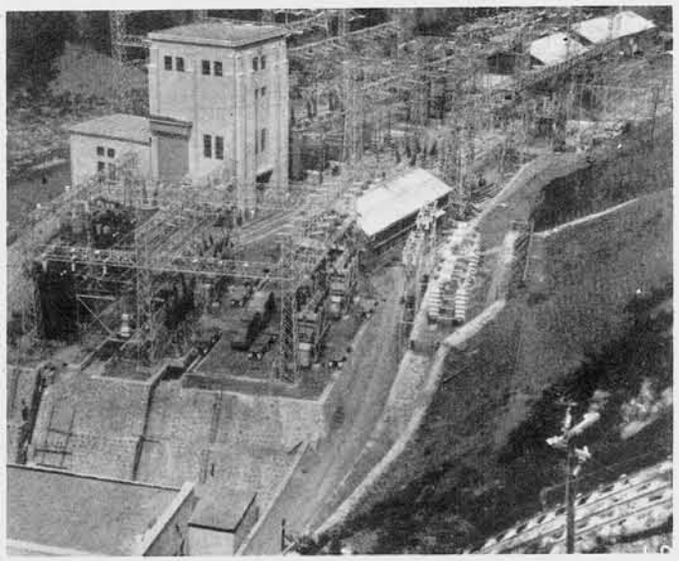
CONFIDENTIAL

RELATED INSTALLATIONS
LARGE POWER STATIONS

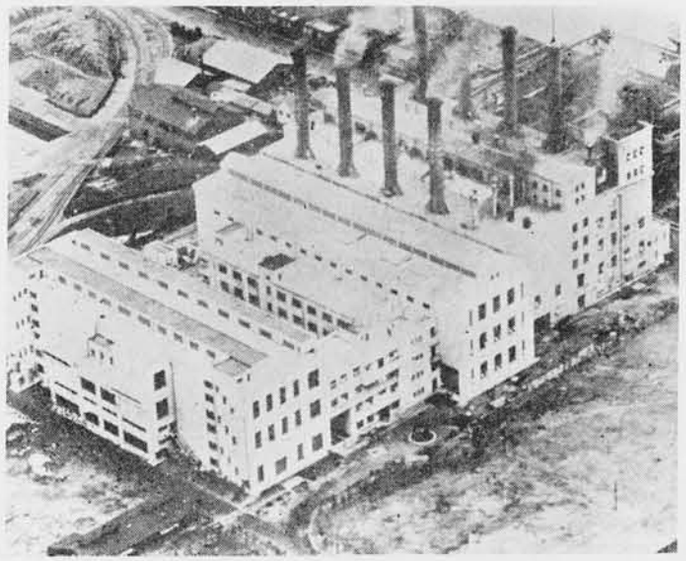
On this page are shown pre-war photos of a few Japanese large scale power stations. These electrification projects are distributed over the Japanese homeland for industry and city power.

Most Japanese power is hydro-electric, which can be easily identified on aerial photos by the penstocks, transformers, and by the large power line towers in the vicinity.

In areas supplied by these stations, individual military power plants, such as are shown in preceeding pages, will not be necessary, and spotting of electronics devices will be more difficult.

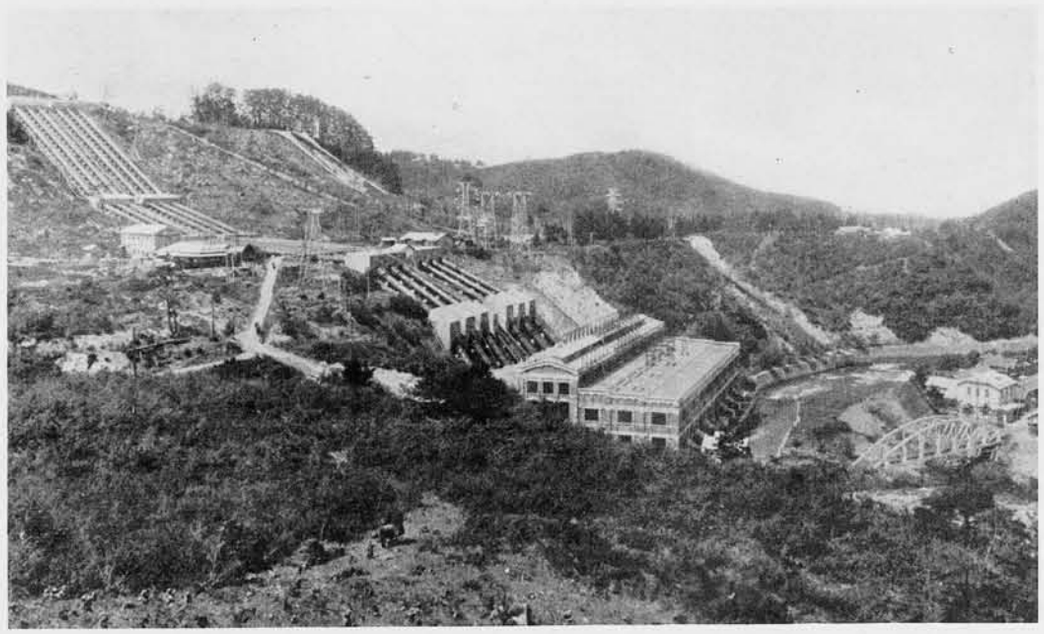


TRANSFORMER ARRAY

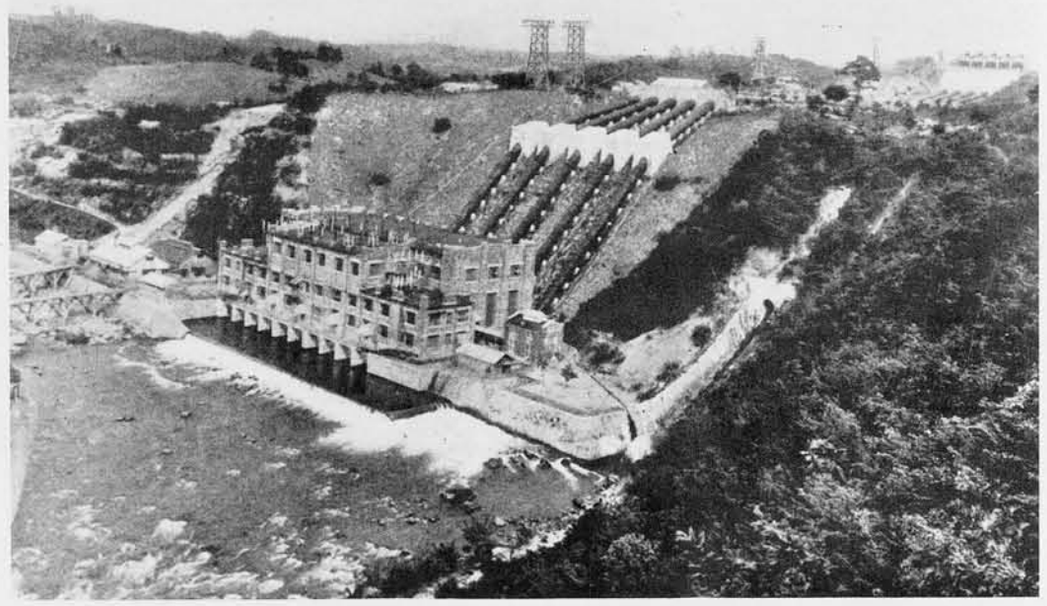


KAWASAKI R.R. POWER STATION

YANAGAWA POWER STATION

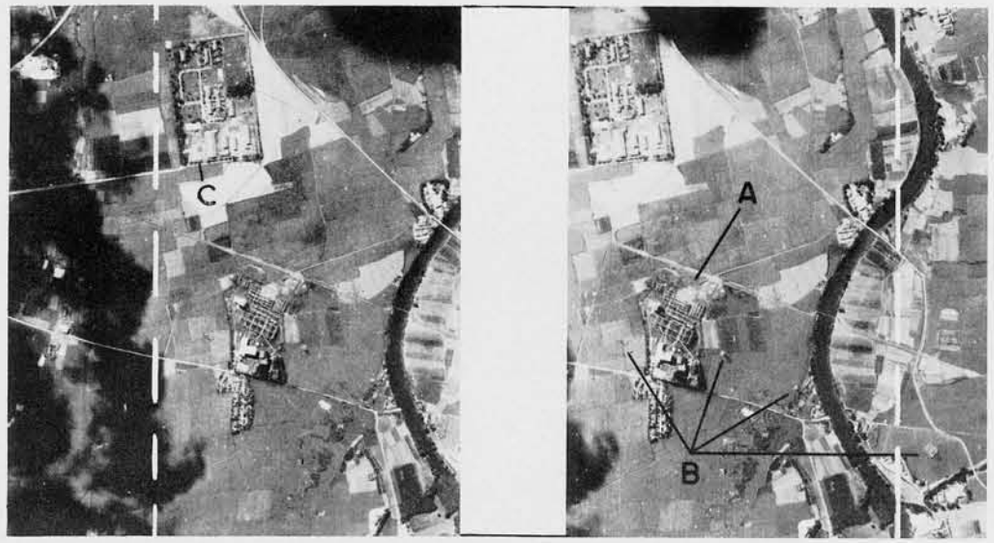


INAWASHIRO STATION NO.1



INAWASHIRO STATION NO. 2

RELATED INSTALLATIONS
TRANSFORMERS

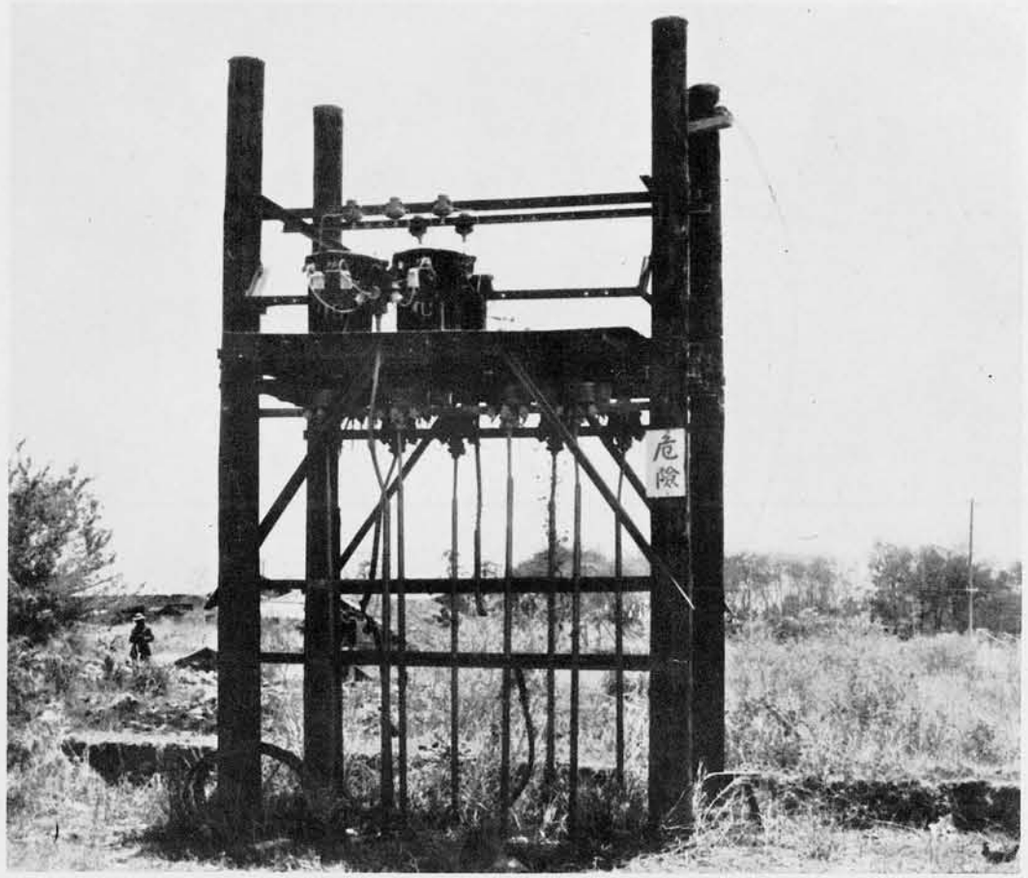


(R.F. - 1/16400)

LARGE TRANSFORMER STATION

Transformer station at Takao, Formosa.
"A" - TRANSFORMERS
"B" - STEEL TOWERS SUPPORTING POWER LINES
Note Radio Station at "C".

MILITARY TRANSFORMER STATION



MILITARY TRANSFORMER STATION

Transformer platform is usually from 12 to 15 feet above ground and is about 8 feet square in vertical view.

MILITARY TRANSFORMER STATION

RELATED INSTALLATIONS
TRANSFORMERS (CONT.)

TELEPHONE CABLE, JAPAN

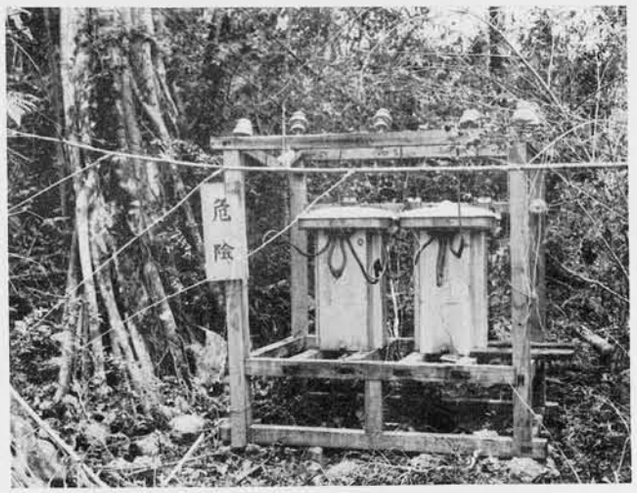
The above two pictures illustrate the method used for supporting central telephone cables in Japan. The loading coils are on heavy steel structures spaced up to 6000 feet apart.

TRANSFORMER

Well-concealed small military transformers at Guam. This sort of practice, not uncommon with Japanese installations, offers a real challenge to the interpreter.

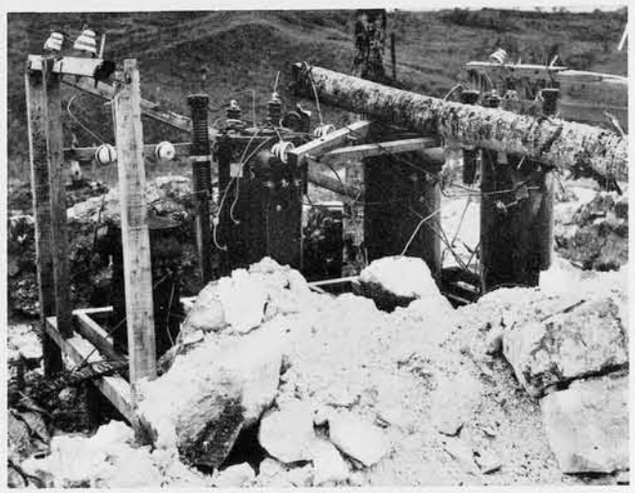
TELEPHONE CABLE. JAPAN

The size and shape of these structures resemble the military transformer stations shown on the previous page. Although such installations may not be vital targets in themselves, they furnish valuable interpretation clues.



TRANSFORMER

Same military transformer on Guam uncovered. Entire installation is about 5 feet square.

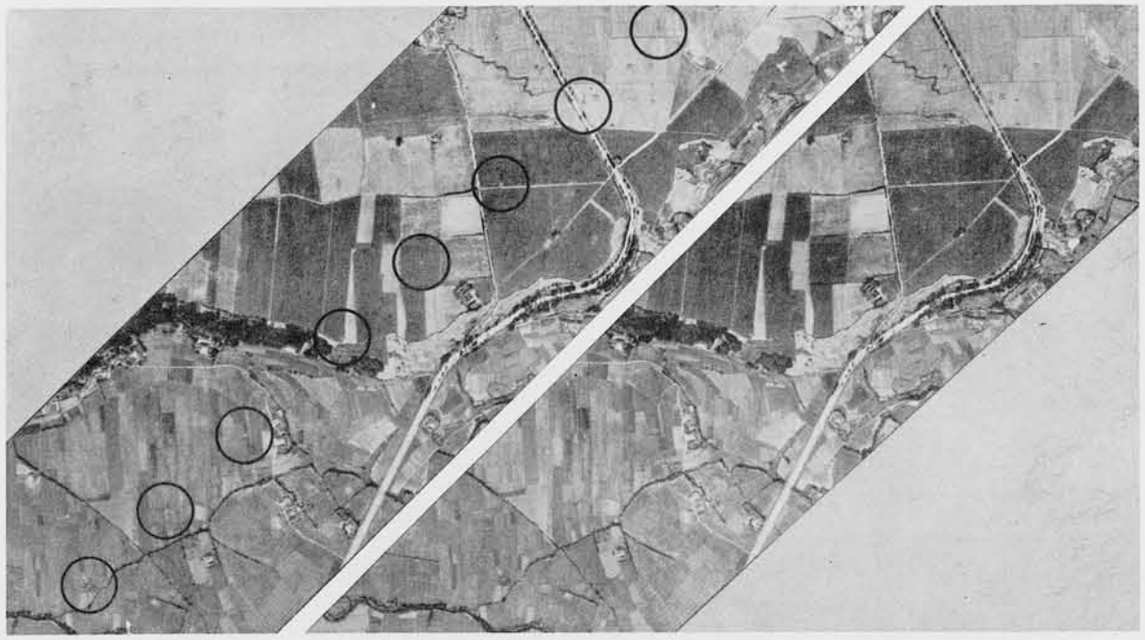


SMALL TRANSFORMER

Transformers for underground power plant - made by a United States company several years ago.

RELATED INSTALLATIONS

TRANSMISSION LINES

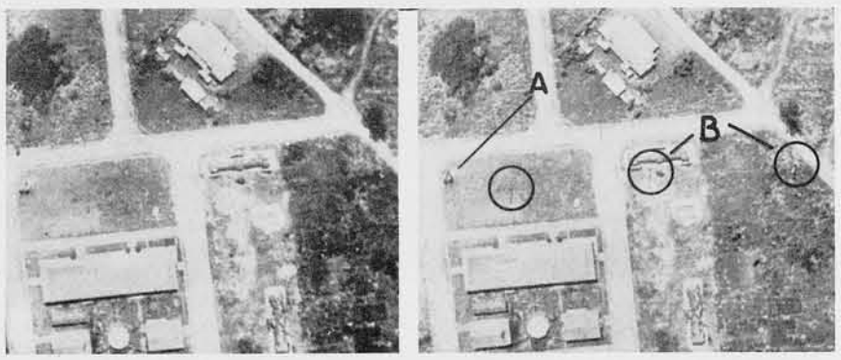


POWER - FORMOSA

High tension lines can be traced across the countryside in this example at Formosa.

POWER AND TELEPHONE POLES - SAIPAN

POWER SAIPAN



POWER SAIPAN

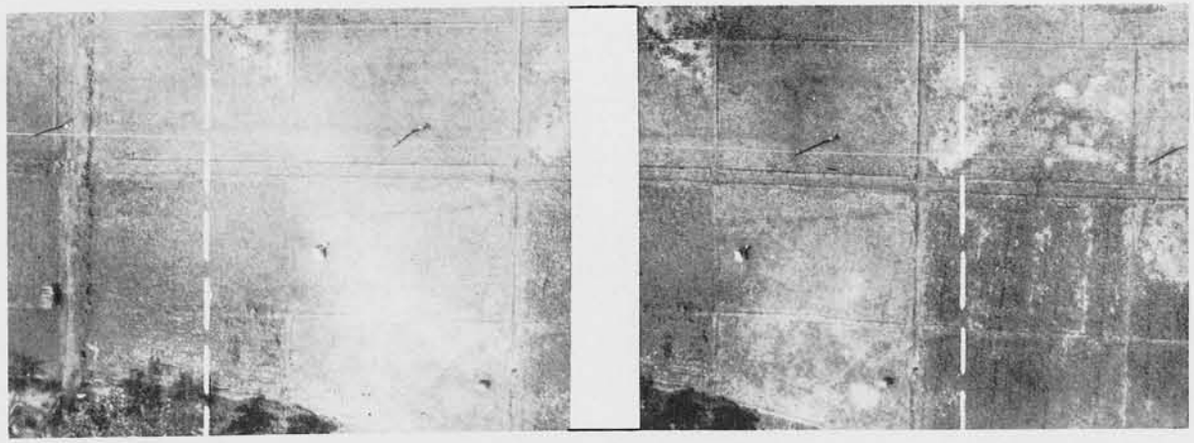
The above two views of transformer station and power line on Saipan offer a good opportunity for reference.

"A" - TRANSFORMER STATION
"B" - POWER LINE POLES

RELATED INSTALLATIONS

TRANSMISSION LINES (CONT.)

Examples are shown on this page of transmission and telephone lines. Steel towers, of the type shown on Java, may sometimes be mistaken for electronics devices such as radio or radar when examined singly, or in a picture of limited coverage.

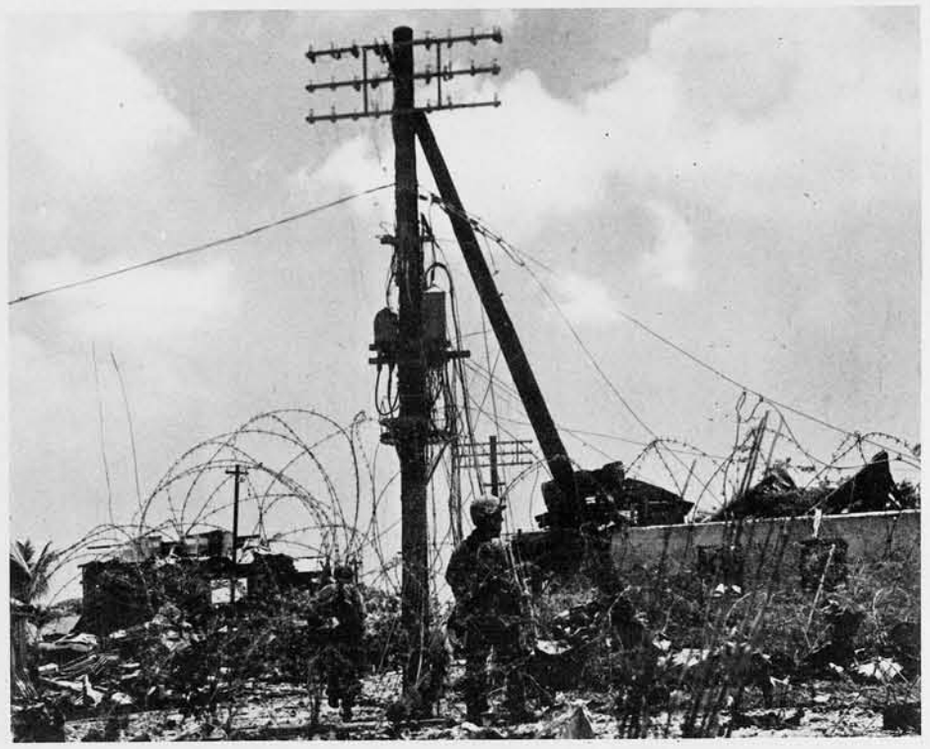


TELEPHONE CABLE, GUAM

POWER LINE · JAVA

POWER OR PIPE LINE SLASH · PALAU

POWER POLES · MANCHURIA



TELEPHONE POLES · SAIPAN

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

SECTION-7

7.01 — 7.99

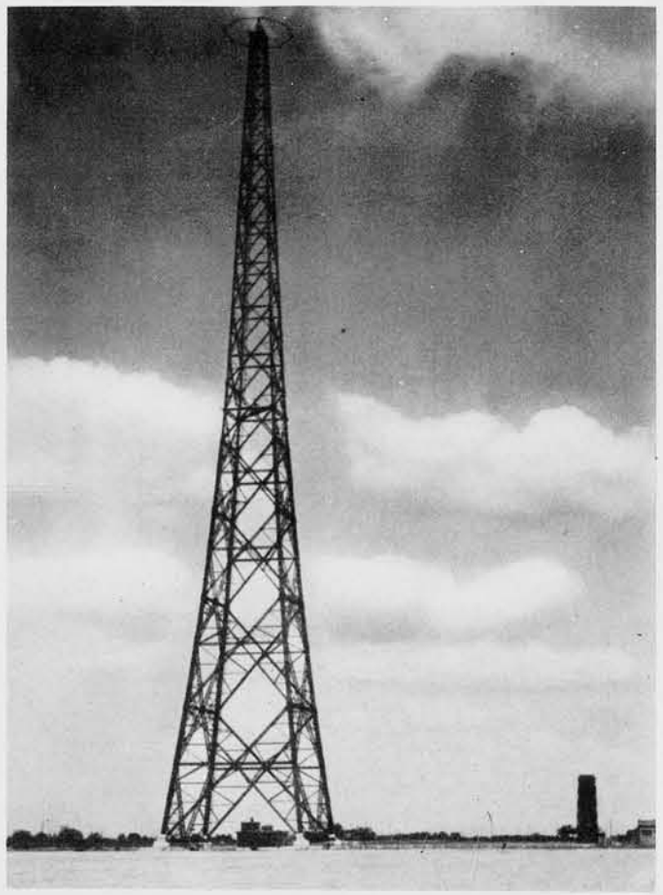
COMPARATIVE STUDIES

COMPARATIVE STUDIES
RADIO MASTS

This section, "Comparative Studies", was prepared as a general treatment of the interpretation of Electronics installations from aerial photographs.

Here are included a few pages illustrating comparisons and contrasts between electronics installations and certain similar appearing non-electronics forms as they show up in aerial photographs.

The first three pages are devoted to studies of radio masts of both Oriental and Occidental design.



GERMAN

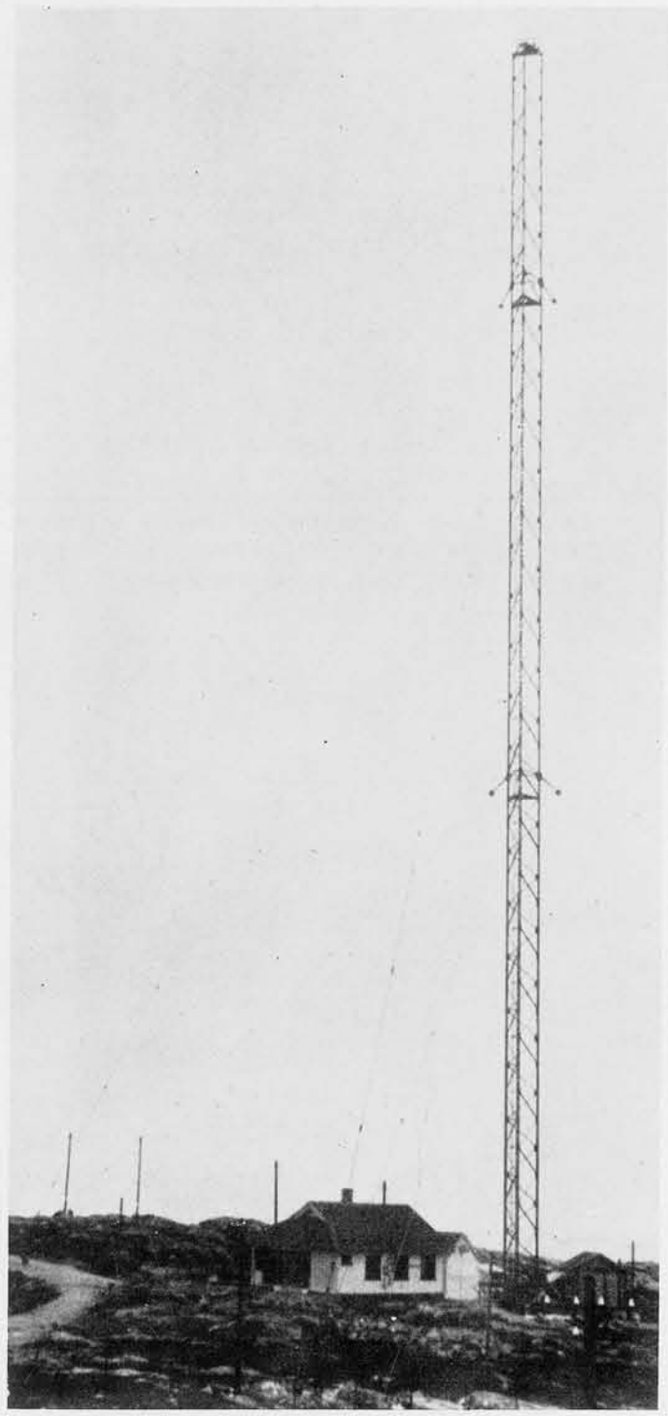
This lattice mast is of German design and is apparently a top loading radiating mast resting on insulators. The steel framework of the tower and the circular form at top transmits radio energy without need for other antennae.

GERMAN

Two radiating masts of German design near Rapopo, New Britain. This was a prewar broadcast station. Note D.F. type towers nearby.

FRENCH

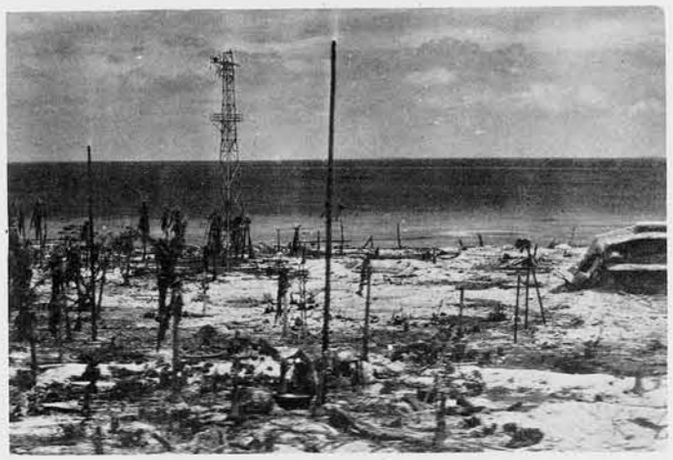
Mast of pre-war "Radio Normandie" broadcast station - Louvelat. Masts of this type, as well as others on this page, are seldom built by the military.



NORWEGIAN

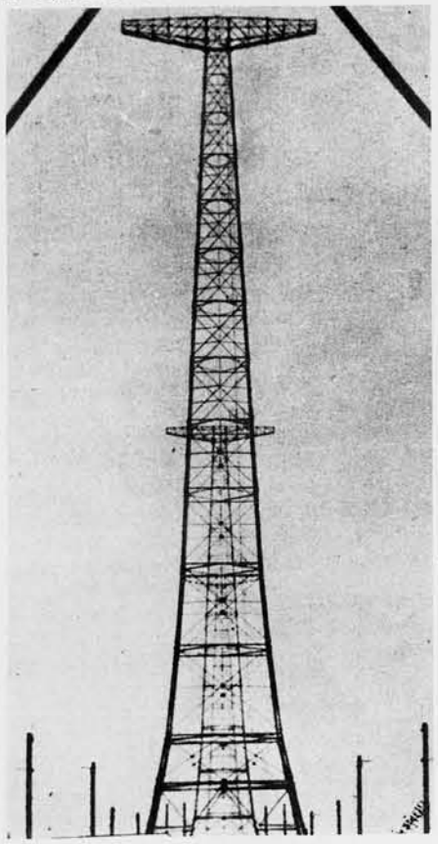
Norwegian mast similar in design to those at Rapopo. This is a pre-war construction, also. All masts on this page are used with medium to low frequency communications.

COMPARATIVE STUDIES
RADIO MASTS



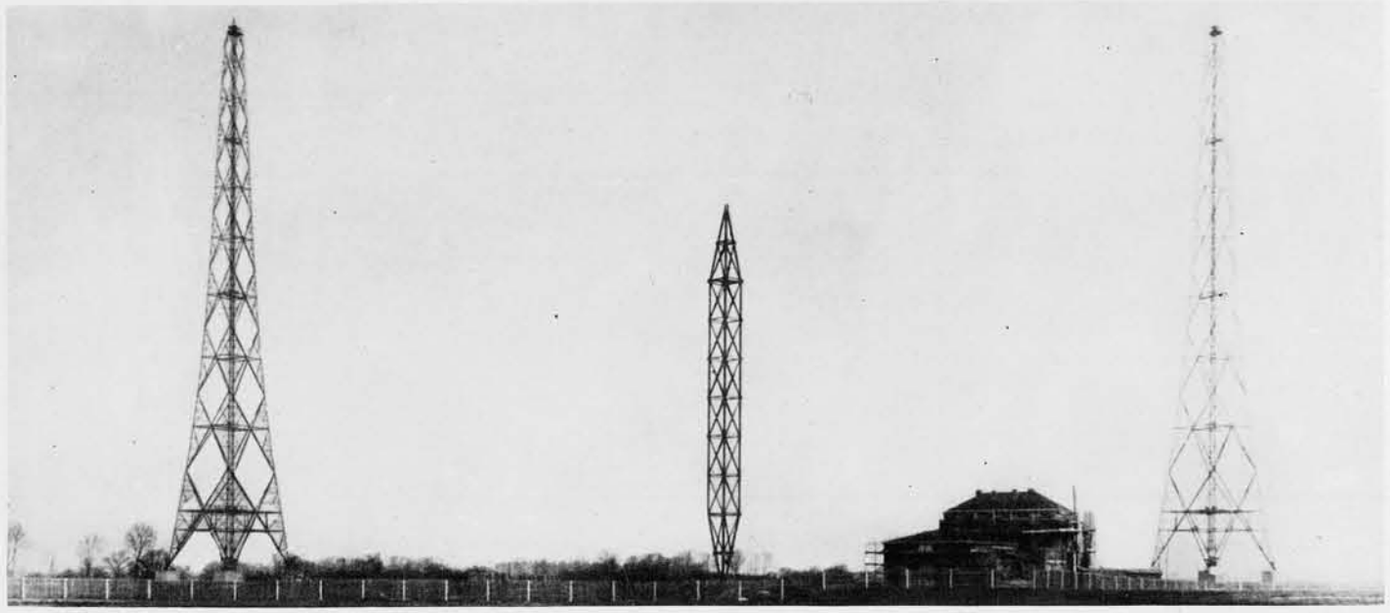
JAPANESE MILITARY STATION

When low wood stick masts are found in close proximity to steel lattice masts, the former probably carry antennae for transmission at higher frequencies.



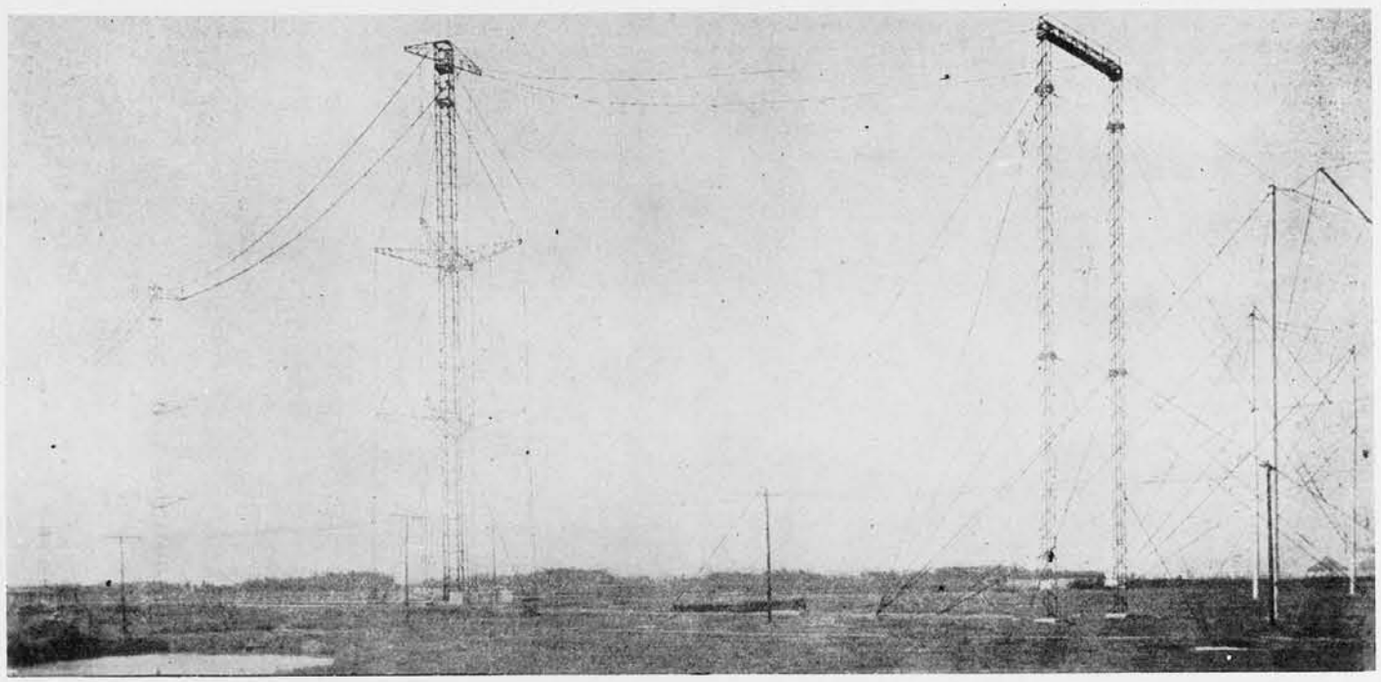
MANCHURIAN

Steel lattice masts of Japanese controlled low frequency station in Manchuria. This station was erected before the war.



GERMAN

Police radio station of pre-war design in Munich. These stations are probably of lower frequency than those commonly used by the German military in this war.

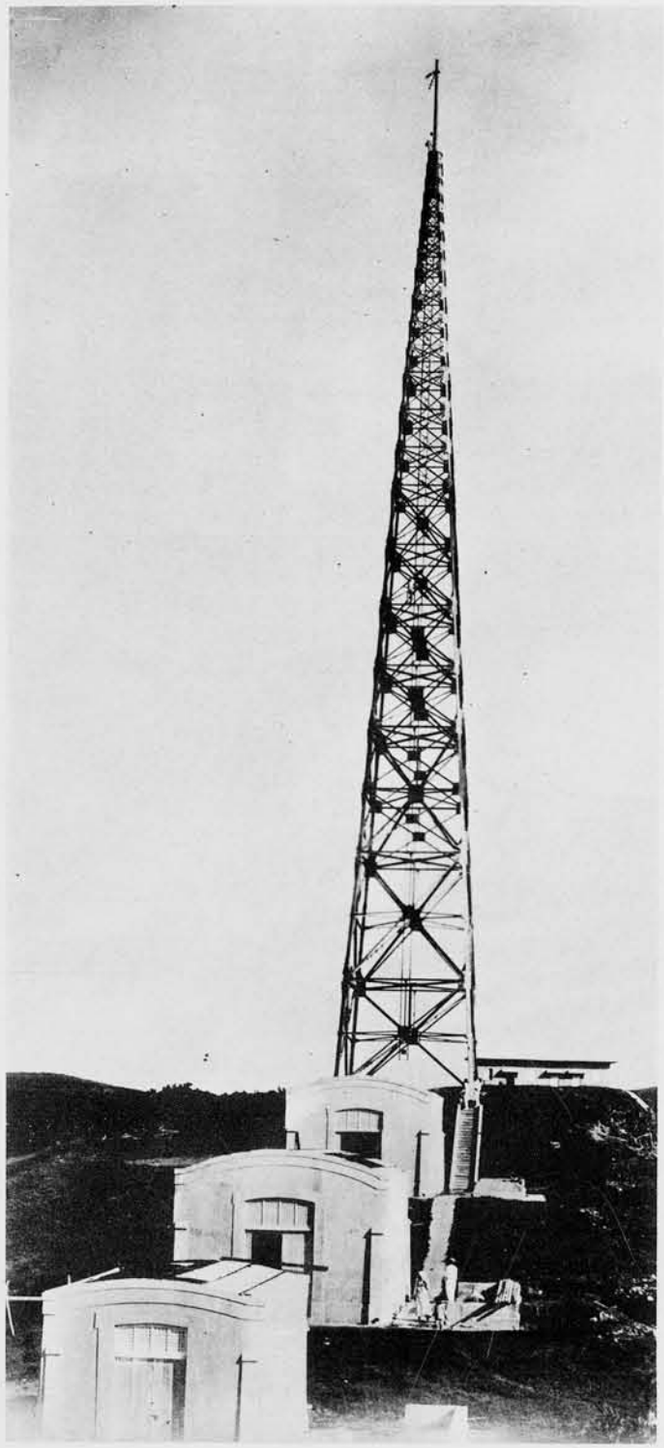


CHINESE

Complex array of antennae and masts used by the pre-war Chinese Government station at Shanghai, called the "Chenju" station. Masts similar to those at left (above) are sometimes used by the Germans for communications.

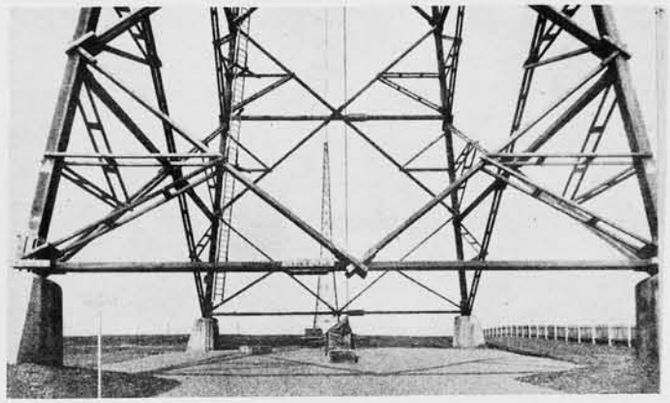
COMPARATIVE STUDIES

RADIO MASTS (CONT.)



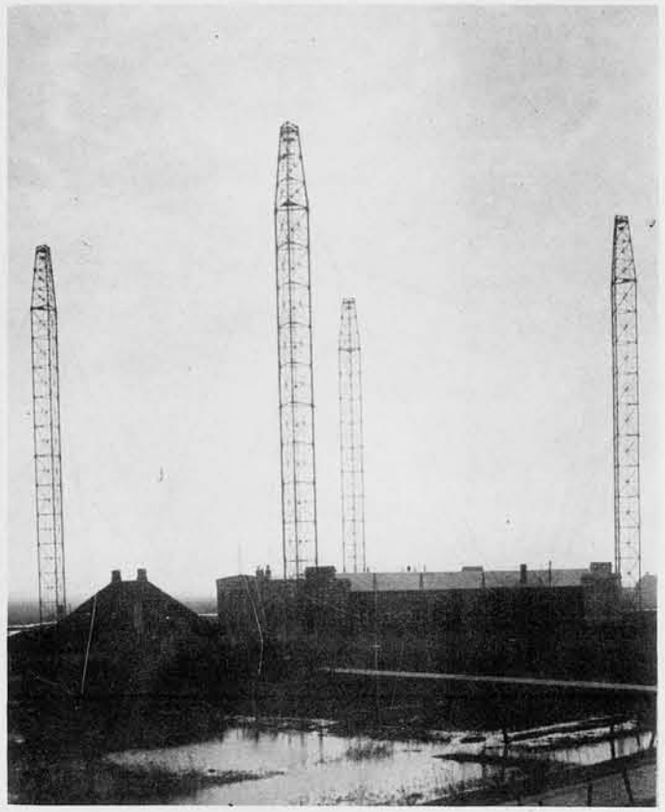
UNITED STATES

Old steel lattice mast at Santo Domingo de Basco. Picture was taken in 1928.



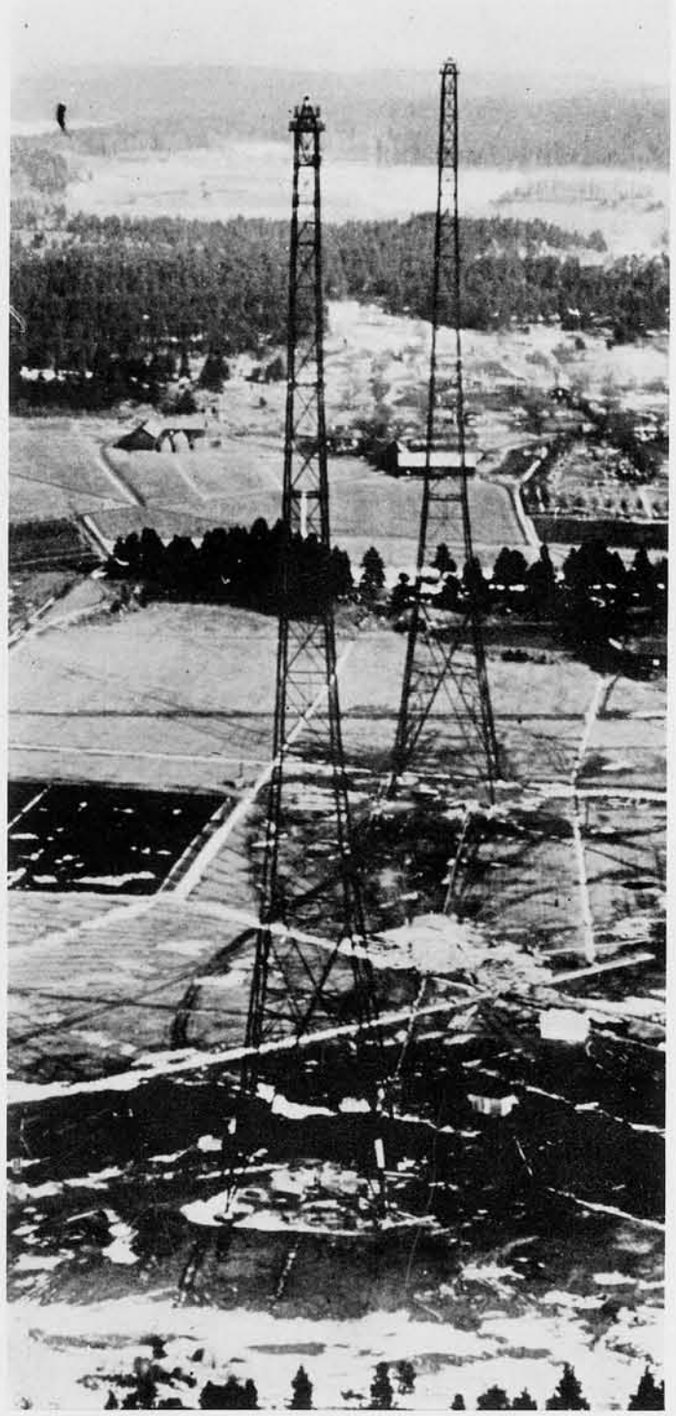
GERMAN

Broadcast station at Wurttemberg, built during 1920's. Bases of masts are made of wood.



GERMAN

Ship to shore station located in Germany. This station undoubtedly has long range and may have navigational aid capacities.

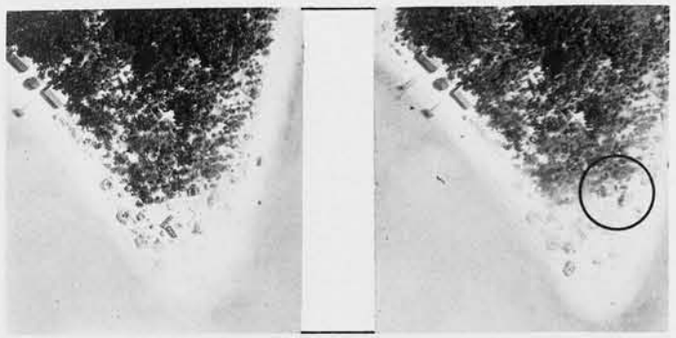


SWEDEN

Steel lattice masts of Stockholm Radio Station. Note radiating pattern of buried cable emanating from transmitter house. Patterns of this type indicate a ground mat or the presence of tuning houses.

COMPARATIVE STUDIES

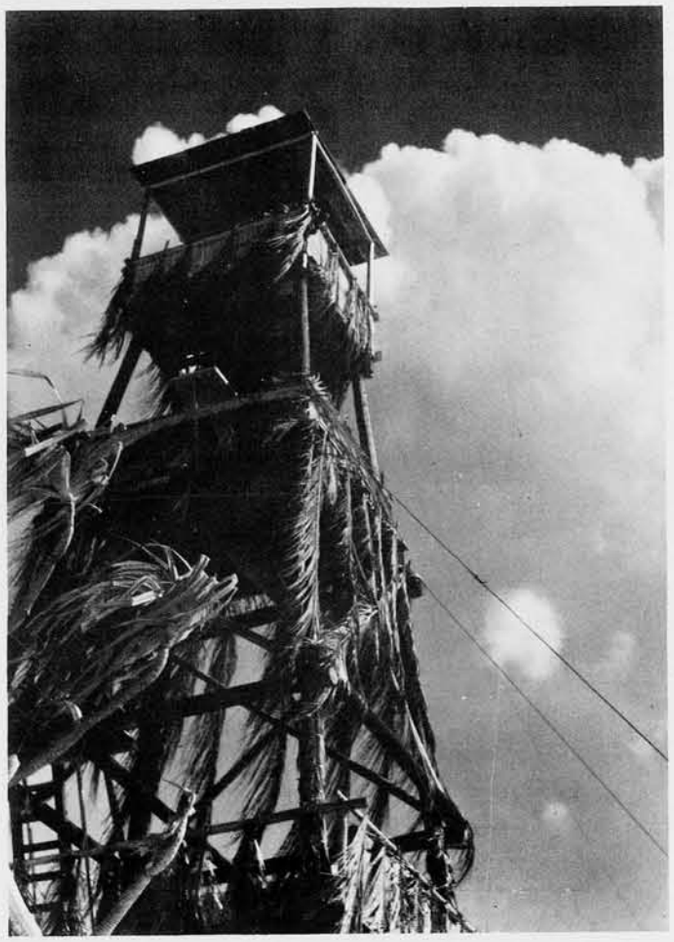
OBSERVATION TOWERS



(R.F. - 1/6700)

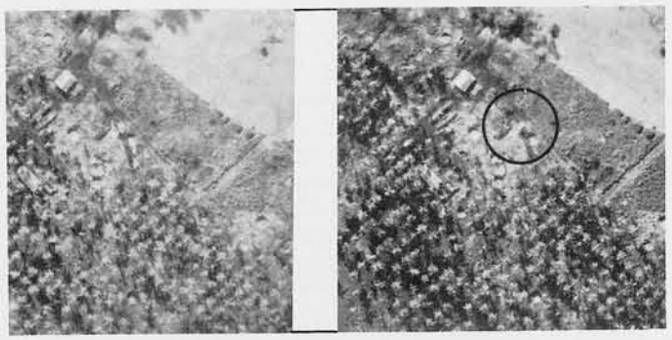
TARAWA

Wooden observation tower at Tarawa. Such towers are necessary on low coral islands for lookouts and for artillery observation.



TARAWA

Same tower at Tarawa, which was used with coast defense guns. Note telephone wires and palm frond camouflage.



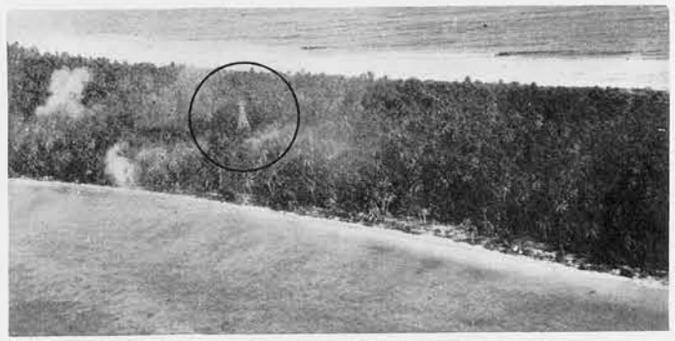
(R.F. - 1/5500)

TOBERA

Wooden observation towers are usually between 40 and 60 feet in height.

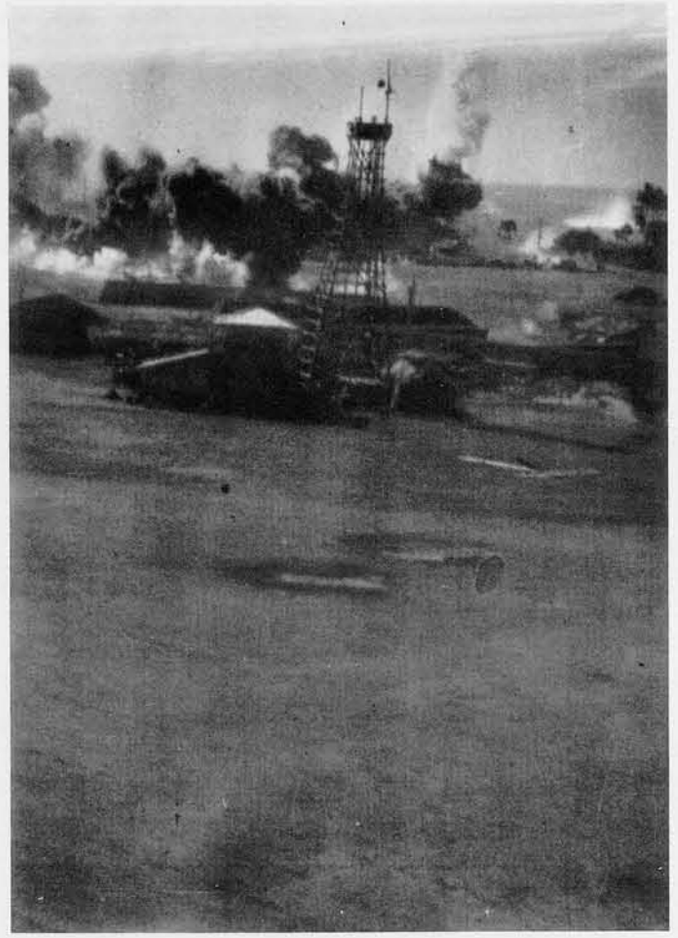
GUAM

Observation tower near Orote Airfield. Note palm frond camouflage and presence of communications lines. Sometimes observation towers near airfields are used as control towers. However, the platform is usually covered and will contain high frequency radio communication in such cases.



UTIRIK

Countless styles of design are found in Japanese observation towers, yet most reflect a nationalistic flavor in arrangement of architectural forms.

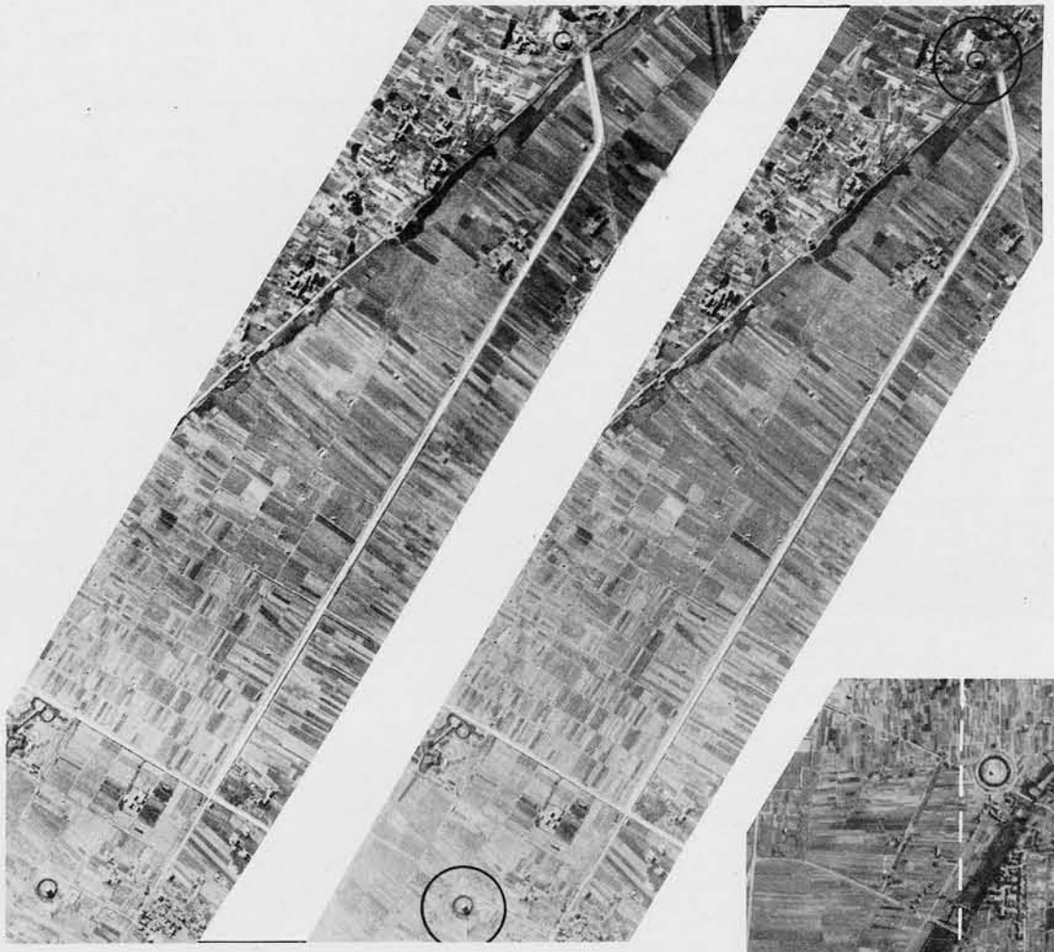


MALOELAP

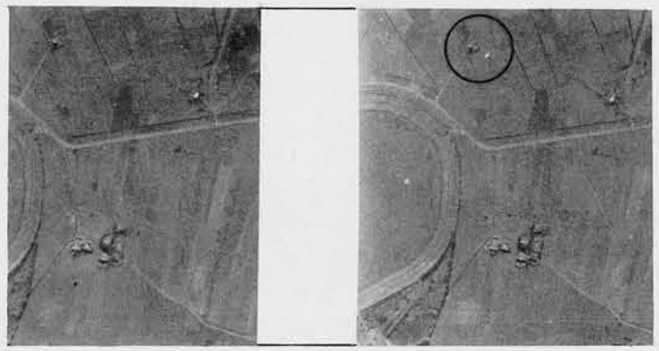
The structural members of a wooden observation tower are likely to give a more horizontal effect than a steel lattice mast. Steel structural members are seldom bent in this manner.

COMPARATIVE STUDIES

DIRECTION FINDERS

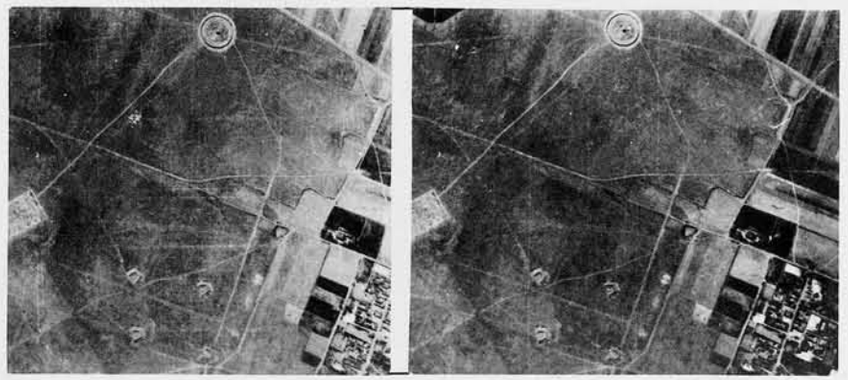


HANKOW (R.F. - 1/17000)



HANKOW

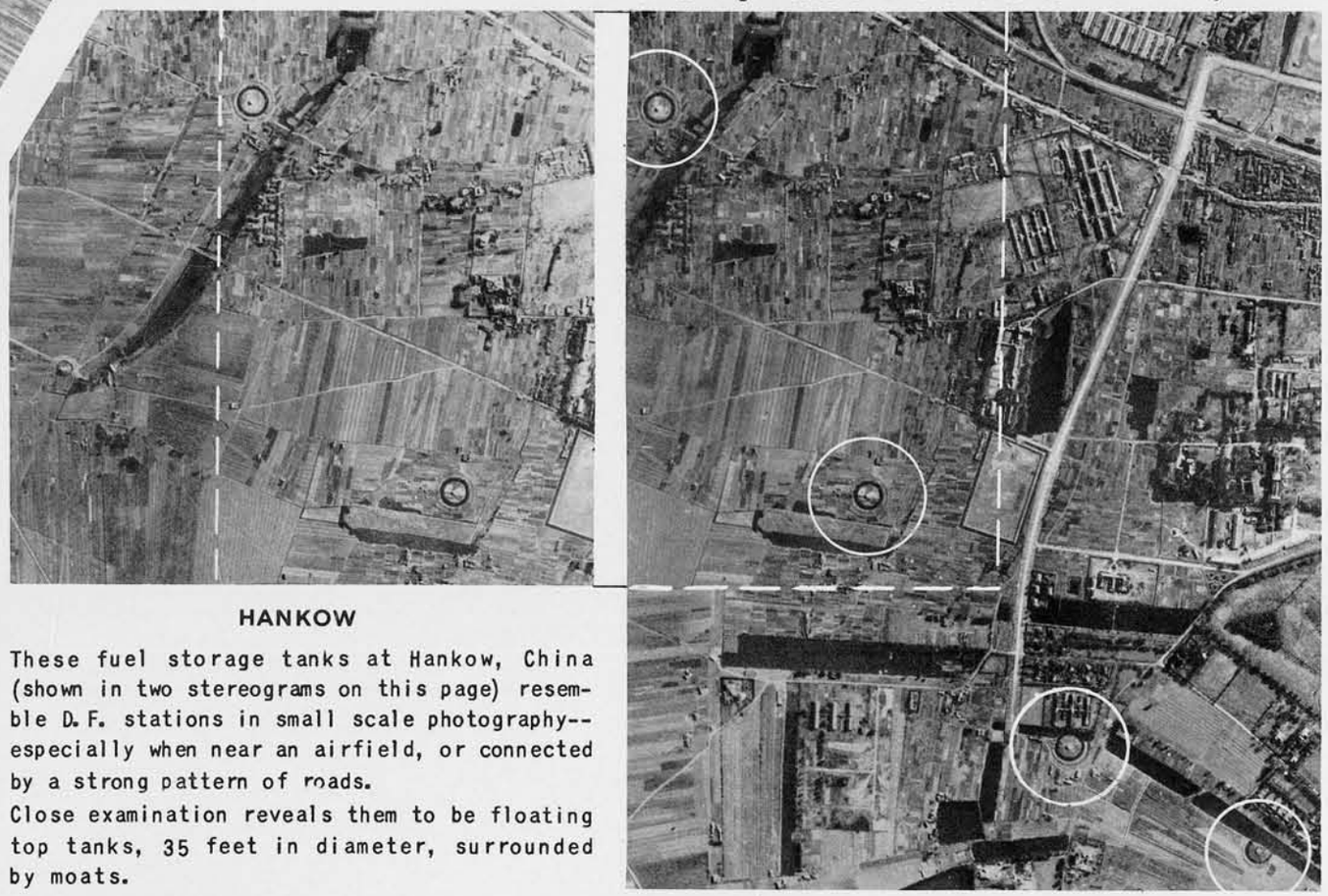
D. F. tower at end of runway surrounded by a square enclosure which is mindful of the German method. D. F. is nearly always present near airfields and each installation is reached by a road or path connection.



YUNCHENG

This installation at Yuncheng is probably a high frequency D. F. tower surrounded by a circular levee for protection against flood. Note small auxiliary buildings within levee. Compare this with fuel tanks at Hankow.

General: There are many comparatively innocent objects that may be confused with vital electronics installations as well as countless camouflage methods and even illusions created by chance.

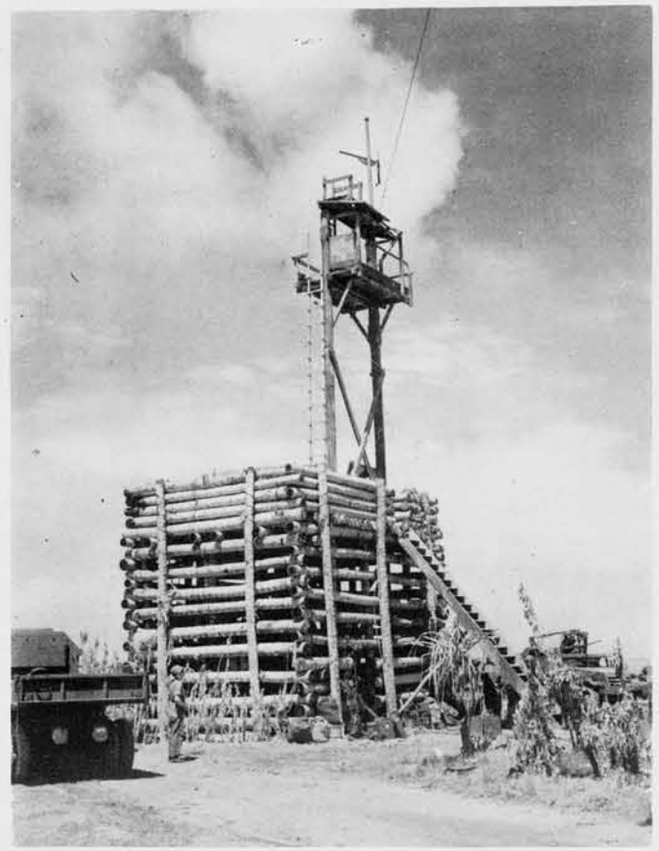


HANKOW

These fuel storage tanks at Hankow, China (shown in two stereograms on this page) resemble D. F. stations in small scale photography--especially when near an airfield, or connected by a strong pattern of roads.

Close examination reveals them to be floating top tanks, 35 feet in diameter, surrounded by moats.

COMPARATIVE STUDIES
SIGNAL TOWERS



MAKIN

ABOVE:

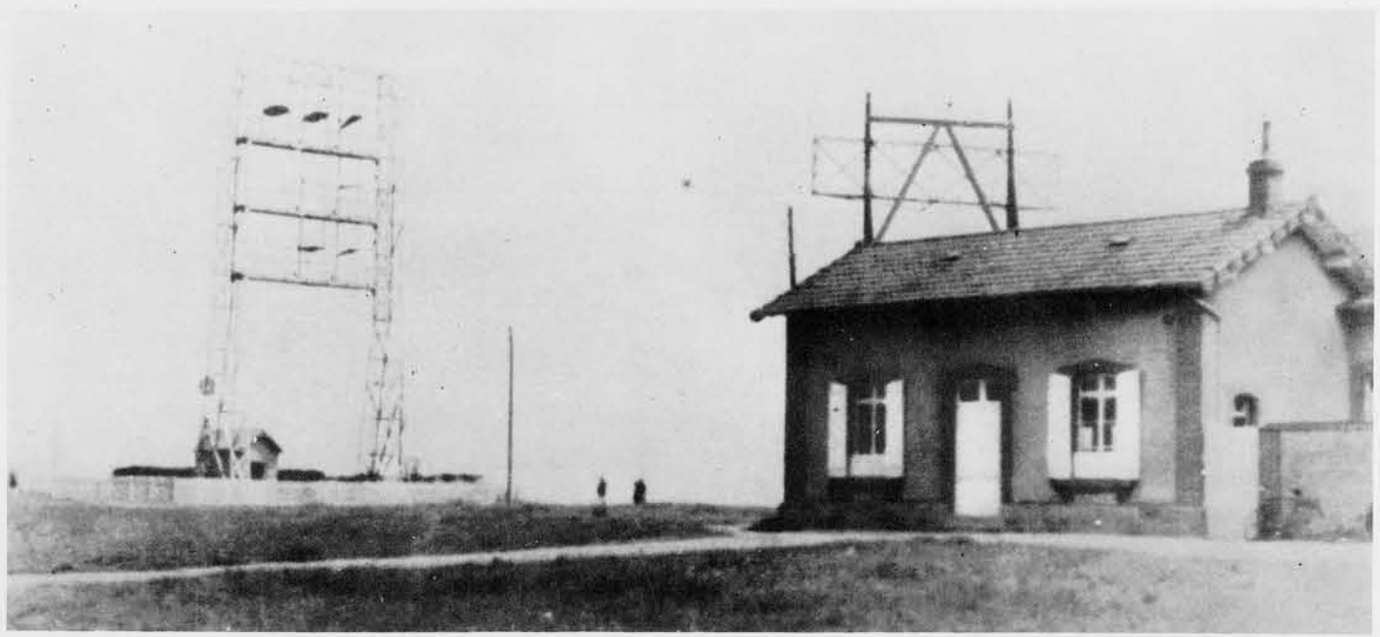
Japanese signal tower at Makin, Gilberts. This base is constructed of coconut logs, lashed together at the corners. Upper portion is braced with guy wires. Note communications line. Tower is approximately 50 feet above ground.

RIGHT:

Although not properly classified as a "Signal Tower", these are shown here for reference. It is thought that this type of tower is used in connection with port direction.

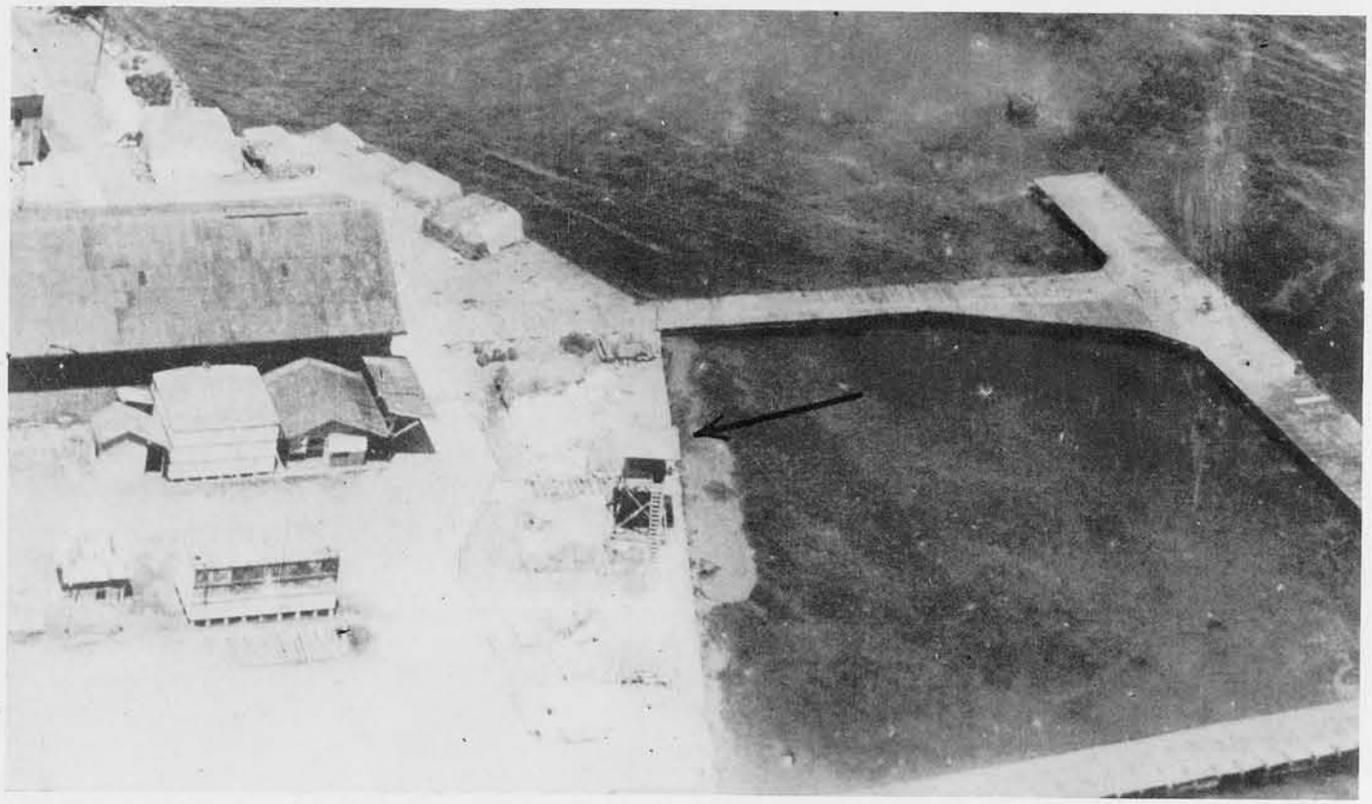
Signal towers, observation towers, as well as many electronics buildings often vary in design because of the whims of local commanders, local builders, and emergency needs - despite the fact that the Japanese military have standard designs for most structures. Even an improvised radar antenna has been found.

This is in contrast to the orderly Germans, whose installations vary from a few standard types but little, and then usually only in dimension.

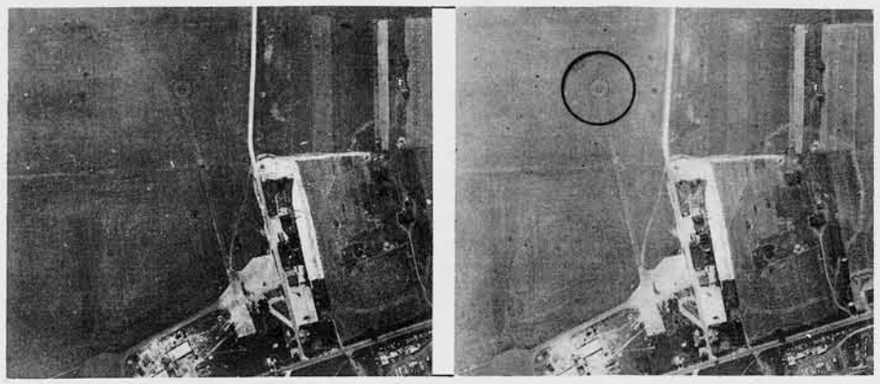


FRANCE

Signal station and semaphore situated near the ocean.

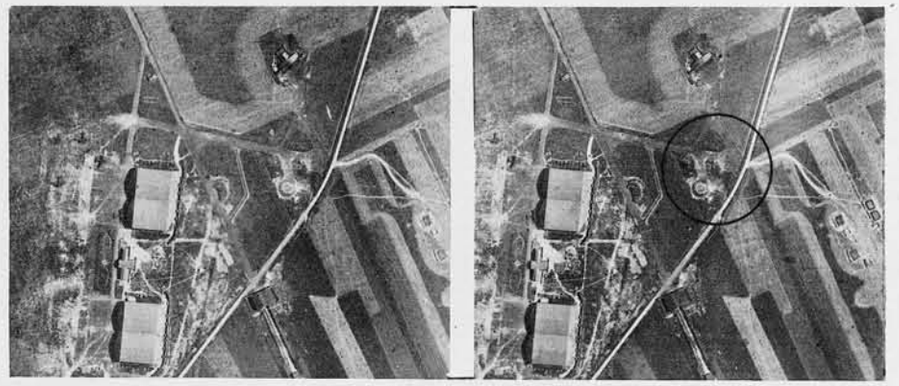


RABAUL, NEW BRITAIN



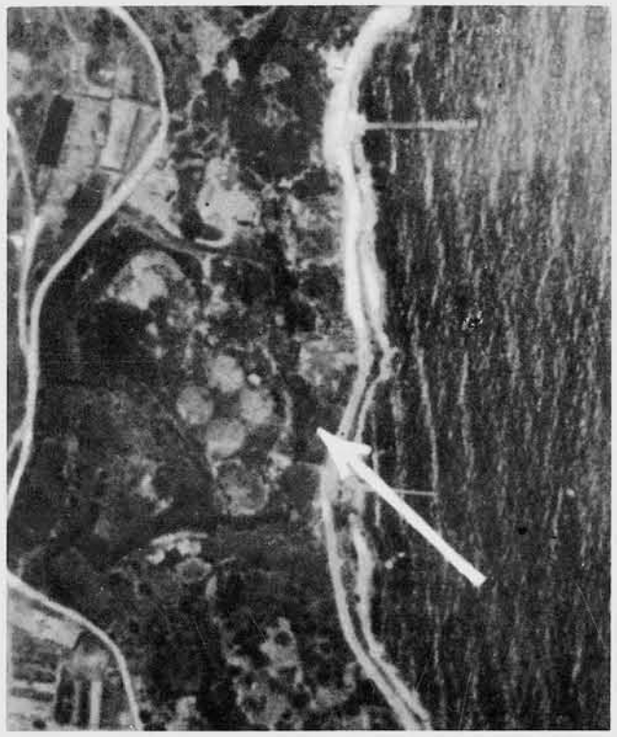
GERMAN COMPASS SWINGING BASE (R.F. - 1/8300)

Most German airfields contain circular patterns connected to a runway spur, which are "compass swinging bases." These are used for checking and setting the plane's compass before taking off on a mission.



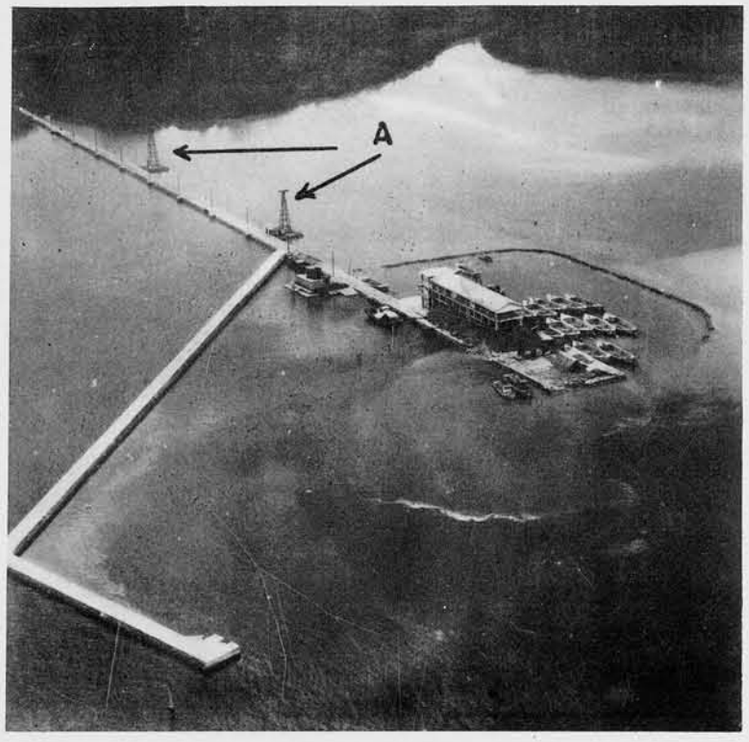
GERMAN COMPASS SWINGING BASE (R.F. - 1/8000)

Another German "compass swinging base" (possibly two). Such installations have not been observed on Japanese airfields to date, as far as is known.



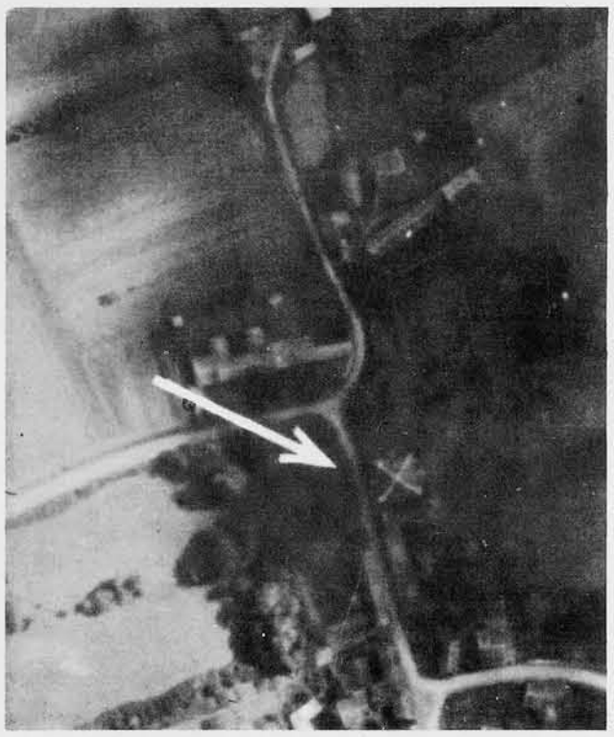
BURIED FUEL TANKS

Buried fuel tanks may look like German type medium frequency Adcock D.F., as can be seen from above photograph.



CABLE CAR TOWERS

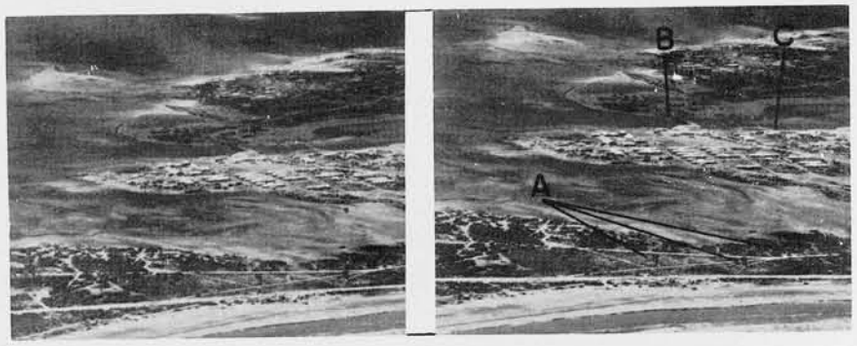
Occasionally, steel towers may be mistaken for radio masts. In this view are two towers which support a cable car used in connection with certain types of industry. This tower design, however, is slightly different from Japanese standard types of radio masts.



DECOY D.F.

What appears to be an Adcock D.F. is actually light-toned ridgelines on the roof of a building in German-held territory.

COMPARATIVE STUDIES
MISCELLANEOUS



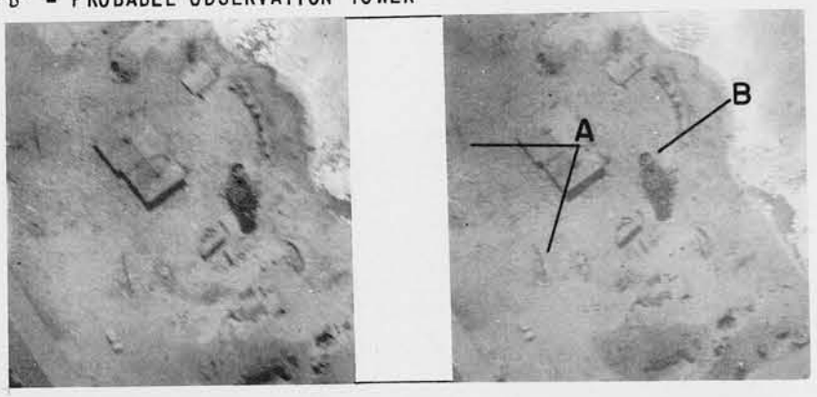
WAKE

in this stereo-oblique are three types of towers used for entirely different purposes.

"A" - HIGH FREQUENCY D.F.

"B" - PROBABLE OBSERVATION TOWER

"C" - WATER TOWER

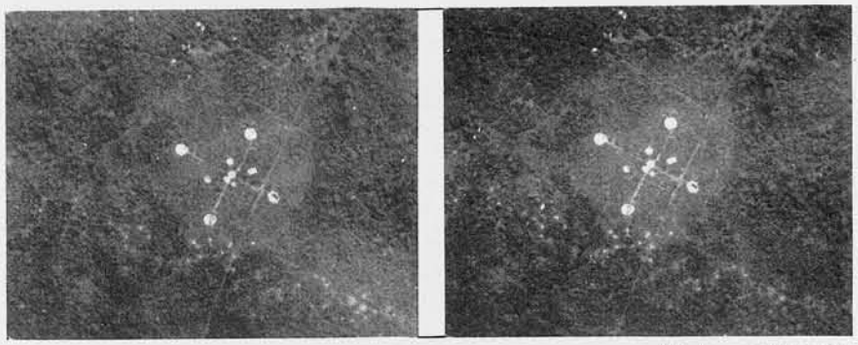


WAKE

Vertical stereogram of a portion of the same area as stereo-oblique shown above.

"A" - TELEPHONE LINE

"B" - PROBABLE OBSERVATION TOWER

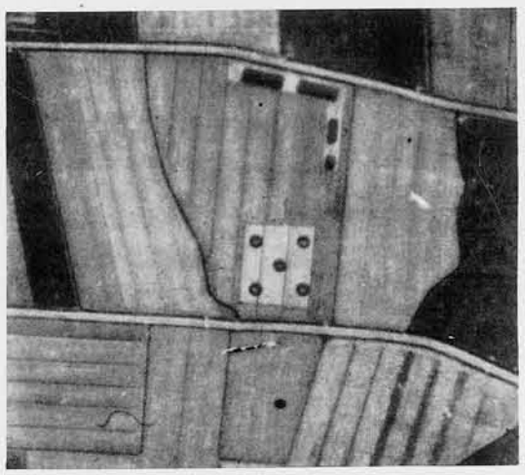


AA BATTERY (R.F. - 1/6000±)

The above pattern, first suggestive of a medium frequency Adcock D.F., is either a new medium AA battery or a decoy. Photograph was taken over Japanese-held territory.

WATER PURIFICATION (R.F. - 1/10400)

This arrangement of forms in Takao, Formosa, indicates a water purification process. The circular form contains the type of geometry often found in electronics installations.

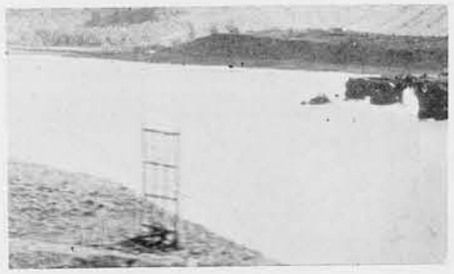


DECOY AA

DOMESTIC PATTERN (R.F.-1/3500)

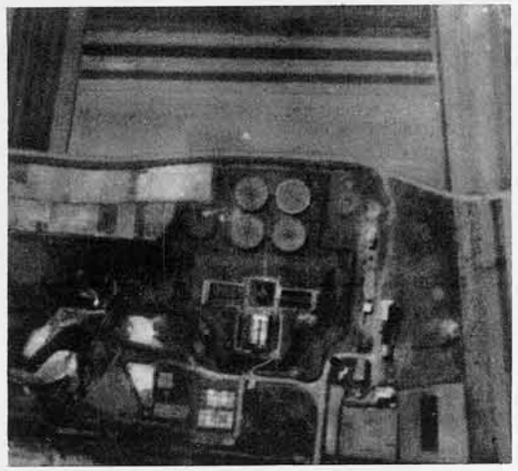
The circular forms (above) are probably the result of using primitive sugar cane processing apparatus.

LEFT: Compare this decoy AA position (German battery) with Japanese AA position on this page. Both may be confused with electronics.



PROBABLE DUMMY RADAR

RIGHT: Sewage plants, at small scale may often appear to be electronics installations. Surrounding buildings and activities usually prevent such an error in identification, however.



SEWAGE PLANT

SUPPLEMENTARY MATERIAL

SUPPLEMENTARY MATERIAL

PUBLICATIONS PREPARED AND AVAILABLE
AT U. S. NAVAL PHOTOGRAPHIC INTELLIGENCE CENTER

● JAPANESE PILLBOXES	FEB. 1944
● JAPANESE SEARCHLIGHTS	FEB. 1944
● JAPANESE AA CD WEAPONS	FEB. 1944
● BARRICADES	APRIL 1944
JAPANESE CAMOUFLAGE	MAY 1944
JAPANESE AIRCRAFT SHELTERS	MAY 1944
JAPANESE SUPPLY DUMPS	JUNE 1944
DETERMINATION OF SHIPS' SPEEDS FROM AERIAL PHOTOGRAPHS	OCT. 1944
JAPANESE LANDING CRAFT	OCT. 1944
UNDERWATER DEPTH DETERMINATION	OCT. 1944
JAPANESE ELECTRONICS	JAN. 1945
JAPANESE MILITARY BUILDINGS	JAN. 1945

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PUBLICATIONS PREPARED JOINTLY BY PHOTOGRAPHIC INTELLIGENCE CENTER AND OFFICE OF ASSISTANT CHIEF OF AIR STAFF, INTELLIGENCE, U. S. A. A. F.

● PHOTOGRAPHIC INTERPRETATION HANDBOOK	APRIL 1944
THE PETROLEUM INDUSTRY	JULY 1944
THE COKE, IRON, AND STEEL INDUSTRIES	SEPT. 1944

PUBLICATIONS UNDER JOINT PREPARATION BY PHOTOGRAPHIC INTELLIGENCE CENTER AND OFFICE OF ASSISTANT CHIEF OF AIR STAFF, INTELLIGENCE, U.S.A.A.F.

THE ALUMINUM INDUSTRY
THE AIRCRAFT INDUSTRY
THE COPPER INDUSTRY
THE LEAD AND ZINC INDUSTRIES
THE MAGNESIUM INDUSTRY
THE MUNITIONS INDUSTRY
THE POWER AND GAS INDUSTRIES
THE SHIPBUILDING INDUSTRY
THE SUGAR AND ALCOHOL INDUSTRIES

● pending revision

[redacted]

SECTION-8

8.01 — 8.99

SEARCHLIGHTS

SEARCHLIGHTS
INDEX

SEARCHLIGHTS

INTRODUCTION

A well coordinated system of anti-aircraft defense includes searchlight positions for use in night fire. In order to properly direct visual gun fire on a swiftly moving target, the fire control director must be provided with certain data necessary for computation of future target positions. To obtain this data the target must be illuminated by searchlights.

Searchlight equipment generally consists of the following four major elements:

1. Searchlight
2. Detector (Sound Locator or Radar)
3. Comparator (Director)
4. Power Plant

SEARCHLIGHT:

Military searchlights employ the high-intensity arc in which the source of light is a ball of luminous gas positioned in a crater of positive carbon. High intrinsic brilliancy is derived from the temperature to which the gases are raised by the passage of current through the arc. The maximum beam candle power of a light is dependent upon the diameter of its reflector (parabolic). The larger the diameter the greater is the range and finding power. The extended hand control is a bar about 10' long attached to the searchlight for manual control in the event of failure of the electrical control system or in the absence of one. The purpose of the length of the bar is to place the operating observer at a maximum practical distance from the searchlight in order to decrease obscurity caused by closeness of the beam.

DETECTOR:

In order to determine the point in space to which the searchlight beam is to be directed, the position of the target is determined by means of a detector. The angular displacement of the searchlight may be controlled directly from the detector. However, for tactical reasons (freedom to utilize the detector to search for and detect a new target once a target is illuminated) it is desirable to control the searchlight from a comparator.

COMPARATOR (DIRECTOR):

An electrical, remote control instrument which is used to control the searchlight. The target is usually engaged from bearings supplied by the detector. Once the target is illuminated the comparator operator, by peering through the binoculars, keeps the target in the beam by manipulation of the right and left side azimuth and elevation handwheels.

POWER PLANT OR GENERATOR:

A source of electrical energy necessary for the operation of the searchlight.

GENERAL FUNCTION OF SEARCHLIGHT EQUIPMENT

Identification of searchlights is based primarily upon the revetments or structures for the light and detector; secondarily, the characteristics of the light itself will be proof of correct identity.

Mobile or fixed Japanese searchlights are emplaced in the following types of revetments:

1. Circular Revetments, at grade or excavated.

2. Double-Wall Revetments.

Revetments containing mobile lights will have an opening large enough to provide egress.

Fixed Japanese searchlights are mounted upon the following types of structures:

1. Raised Circular Platforms.

2. Raised Revetments, circular or rectangular.

3. Raised Rectangular Platforms.

A sound locator becomes a distinctive identification feature when emplaced within a saucer-like revetment. The concave surface evidentally increases accoustical efficiency while protection is afforded by the height and thickness of the wall. Revetments with an inside diameter of 35' have been common, and at Rabaul such a revetment was observed to contain a Model 1930 sound locator. Within Japan proper and China, concave revetments 50' to 70' in diameter have been observed to accompany searchlights; such positions may contain the large type of sound locator (or a modification thereof) which was developed previously to the Model 1930.

Radar controlled searchlights were first captured in the Marianas Islands, and to date have not been emplaced in such a way as to be distinctive.

Although differing in size and detail, searchlights are similar in photographic appearance, having a distinctive rounded shape and shadow. Searchlights have been mistaken for AA guns (on aerial photographs), but in comparing their respective bulk, the light appears to be larger and more rounded than an AA gun and its shadow larger than the thin shadow of a gun. Lights are commonly canvas covered for weather protection with the result that such lights often appear practically white in photographic tone.

Searchlights are located about important targets at regular distances, in belts, or in concentrations for intensive coverage. Since searchlights are primarily part of the anti-aircraft defense plan, lights and AA batteries are closely related.

PHOTOGRAPHIC INTERPRETATION

The Japanese do not necessarily employ all four units of equipment mentioned under "General Function". A detector may be used to maintain continuous control of the light in place of a comparator, manual control, or a master light system (see page 8.25). It is possible, but as yet unproven, that searchlight control equipment may be incorporated in the fire control center of an associated gun battery. The source of power may be a community station rather than a generator used exclusively for the searchlight. Such deviations as mentioned above, plus the occasional housing of light and generator in one structure, reduce the number of units that appear photographically. Units of the searchlight set-up will be found situated at some distance from each other; if photographs are of good quality, connecting cables or evidence of their burial may sometimes be seen.

The following size (diameter of reflector) searchlights have been captured from the Japanese.

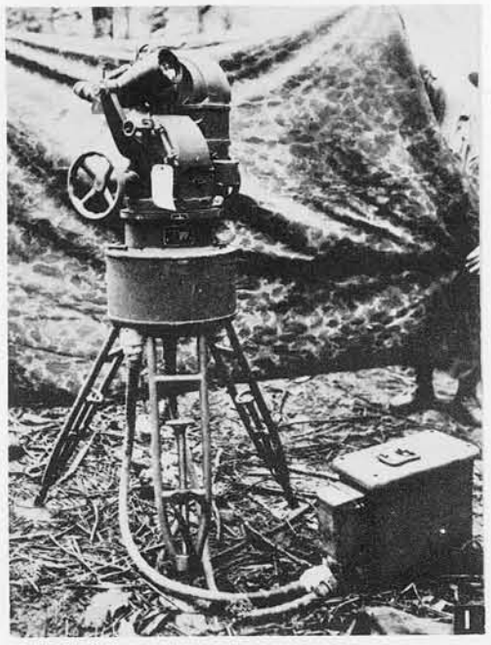
60 cm (23.6")	100 cm (39.4")
75 cm (29.5")	110 cm (43.3")
90 cm (35.4")	150 cm (59.1")
98 cm (38.6")	

The 150 cm (59.1" reflector) light has been found to be more common than any other in captured territory. The approximate dimensions of this light are:

Height - 87" Width - 72" Length - 100"

SEARCHLIGHTS

EQUIPMENT, SOUND LOCATOR CONTROL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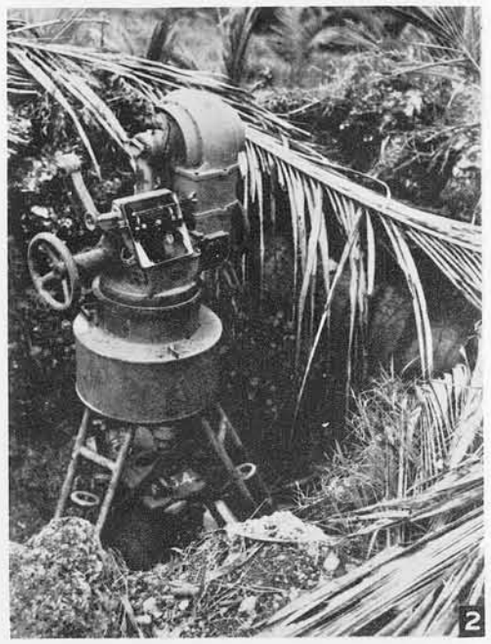
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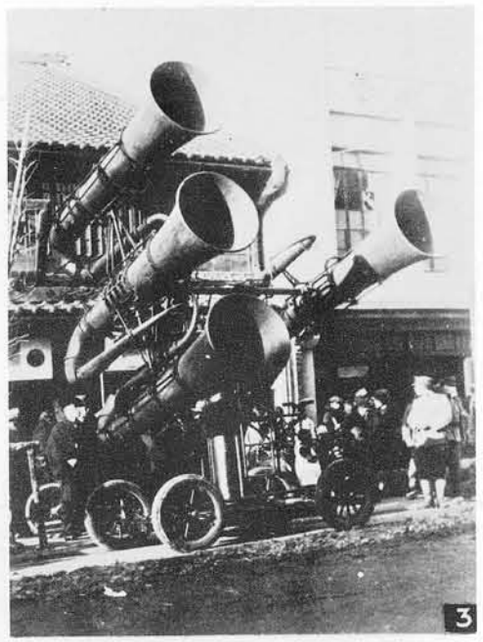

3

1. Model 1933 Comparator for use with the Model 1930 Sound Locator and Model 1933 150 cm. Searchlight.

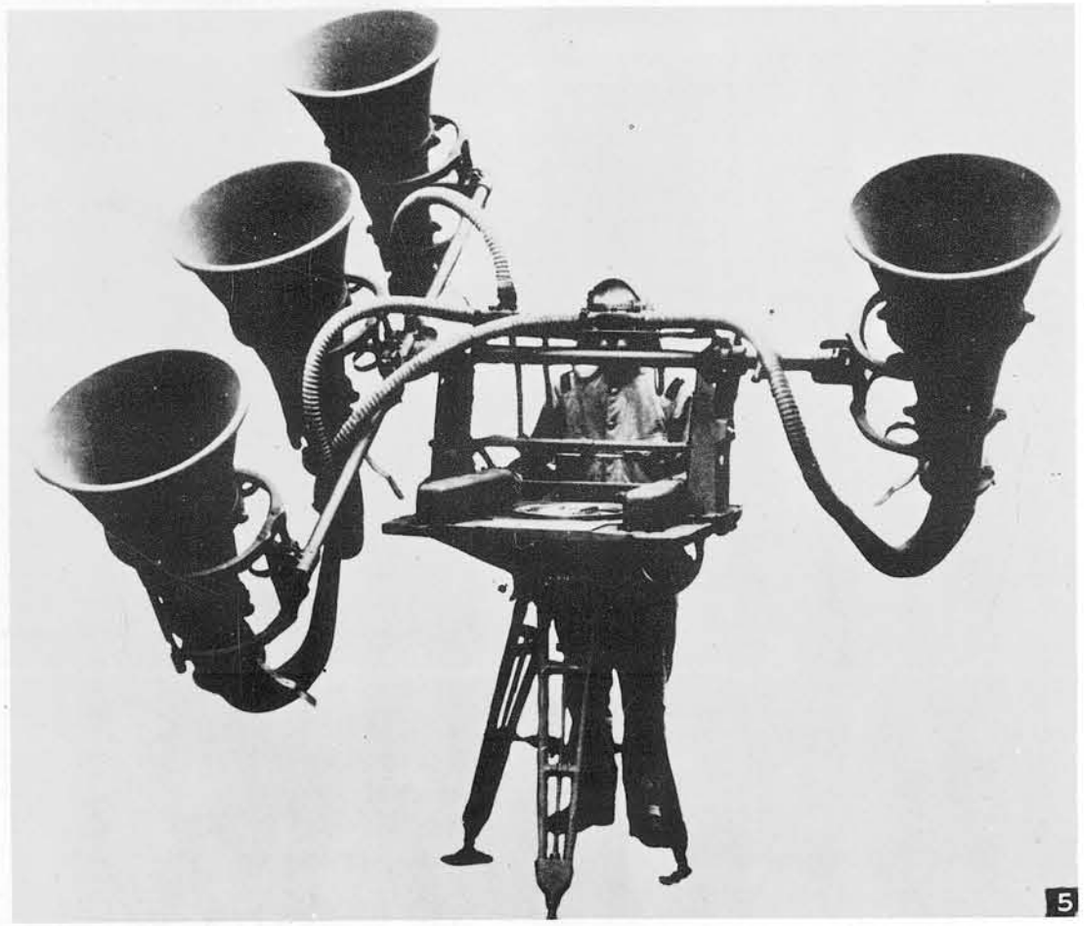
2. Model 1933 Comparator in place showing its small size and ease of concealment.

3. Large type Sound Locator which antedates the Model 1930. This equipment may be encountered in the Japanese Homeland.

4. Model 1933 (or a modification thereof) 150 cm. Searchlight with canvas cover.

5. Model 1930 small Sound Locator. Due to light construction it is rarely observed unless revetted.


4


5

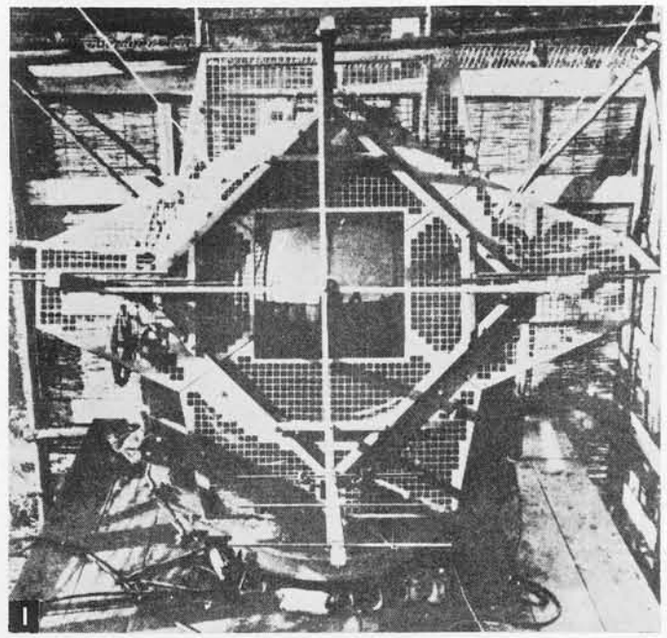
SEARCHLIGHTS
EQUIPMENT, RADAR CONTROL

The "MK. IV, Mod. 3" Searchlight Control Radar is evidentally a Japanese adaption of the British S.L.C. and consists of two parts:

(A) Transmitter with Yagi antenna mounted on a searchlight controller, the mount (with operator's seat) revolves and is about 8' wide.

(B) Receiving antennae of 4 Yagis attached to the face of a 110 cm. searchlight.

1. Captured photo of Receiving Antennae.
2. Transmitter with Yagi Antenna removed - PELELIU.
3. Captured photo of Transmitter Antenna.
4. Emplaced Transmitter Antenna - SAIPAN.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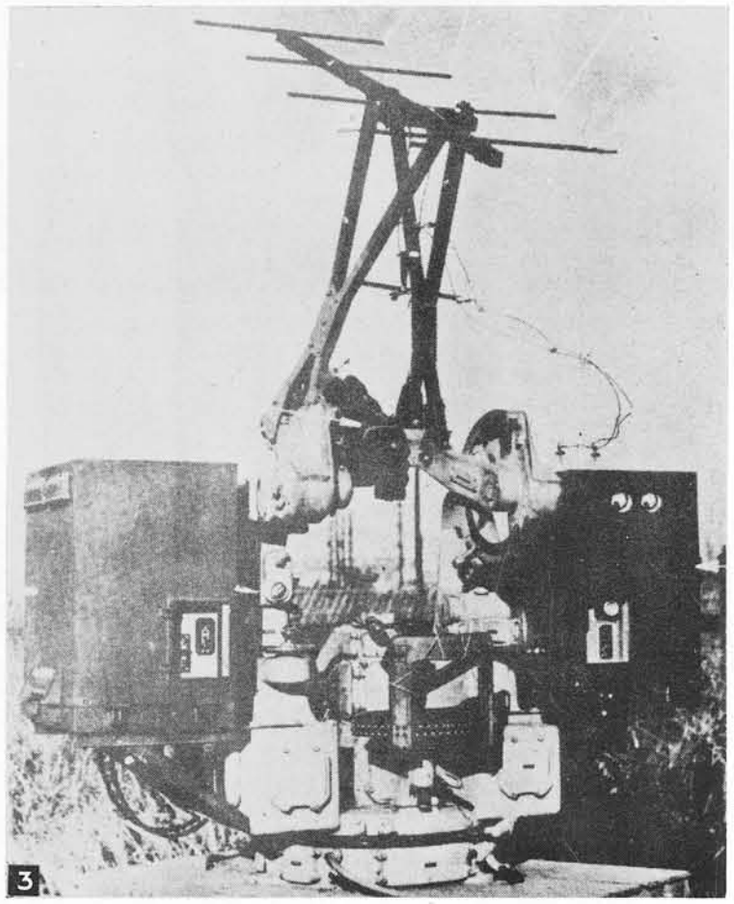
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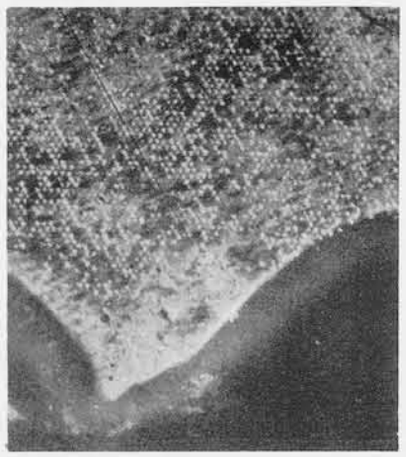
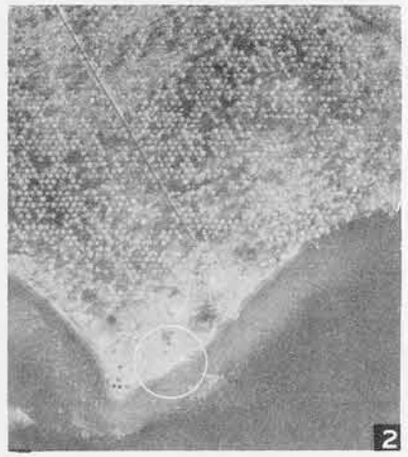
4

SEARCHLIGHTS

RAIL CONNECTED POSITIONS AND GENERATOR TRUCK REVETMENTS

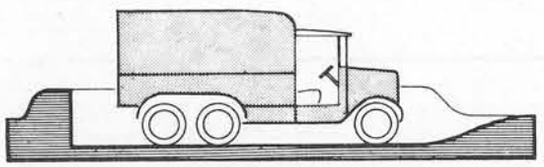

1




2


3

1. VILA, KOLOMBANGARA ISLAND. This rectangular revetment, 15' x 30', contained a generator truck for searchlight operation.
2. VILA, KOLOMBANGARA ISLAND. 1:10,000. A stereo-pair of the revetment shown in #1.
3. VILA, KOLOMBANGARA ISLAND. Two generator trucks and two 150 cm. searchlights. The generator is operated by the truck engine.
4. WAKE ISLAND, 1:4000. A raised searchlight revetment and protective shelter, 40' apart, are connected by rail. The position is 800' from a coast defense battery and commands a clear seaward sweep. During daylight hours or periods of disuse, the light is housed in the shelter.
5. PEALE ISLAND, WAKE, 1:3250. Rail connected searchlight position and shelter are 100' apart; the complete unit is 900' from 8" coast defense battery.
6. ROI ISLAND, KWAJALEIN ATOLL. The remains of this position are similar to those of Wake Island. The light is the 150 cm. size; tracks are about 3' wide.



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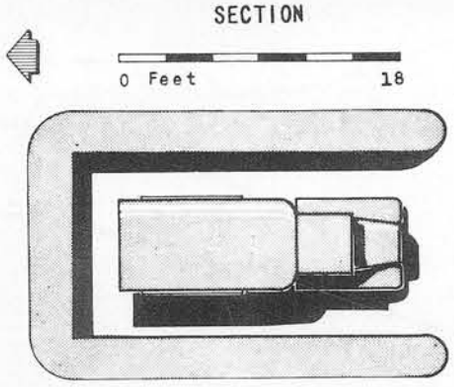
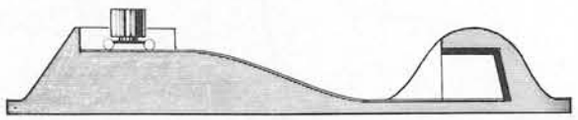


0 Feet 18

PLAN-GENERATOR TRUCK



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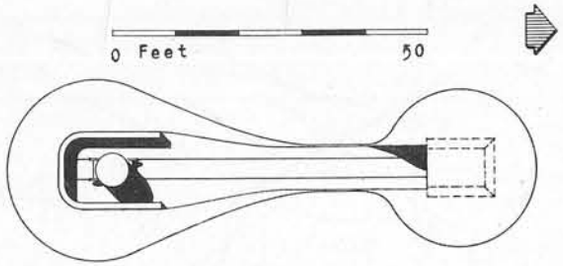
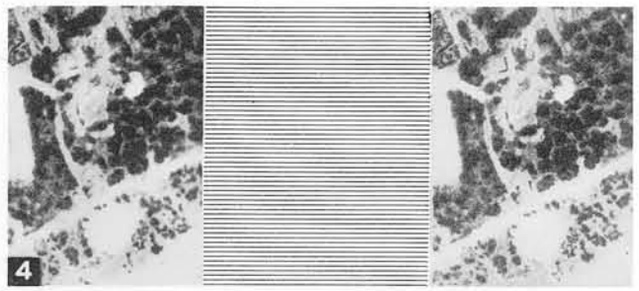


0 Feet 50

PLAN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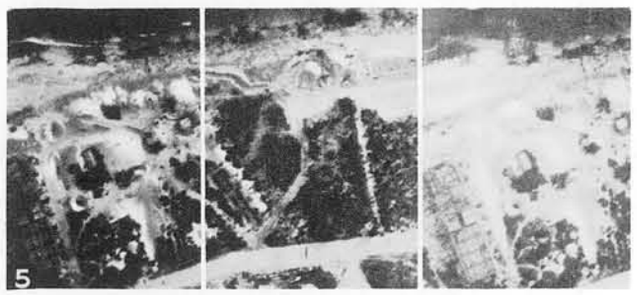
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6

SEARCHLIGHTS

CIRCULAR REVETMENTS

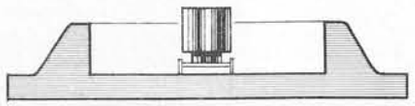
Circular revetments are the most common emplacements for searchlights. Inner diameters vary from 8' to 35'. A 150 cm. light with extended hand control requires a 27' diameter (or larger) revetment since the radius from the light center to the end of the bar is 12'. Openings in revetment walls, if over 6' wide, will accommodate mobile lights.

1. MANILA, LUZON ISLAND, 1:3000. Searchlight with manual control bar in a 27' revetment. The 15' revetment with adjacent pit indicates a sound locator and comparator.

2. MAIN CAMP, KISKA ISLAND, 1:3050. A 16' diameter revetment containing a 98 cm. fixed searchlight. The building in the upper left is a sub-station to increase amperage from regular lines.

3. MAIN CAMP, KISKA ISLAND — 98 cm. fixed searchlight

4. VILA, KOLOMBANGARA ISLAND — 150 cm. searchlight



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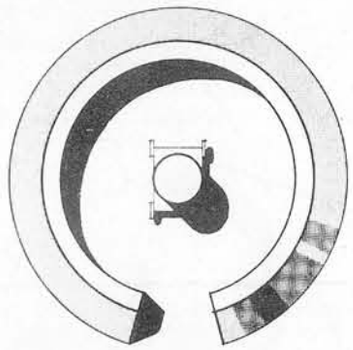
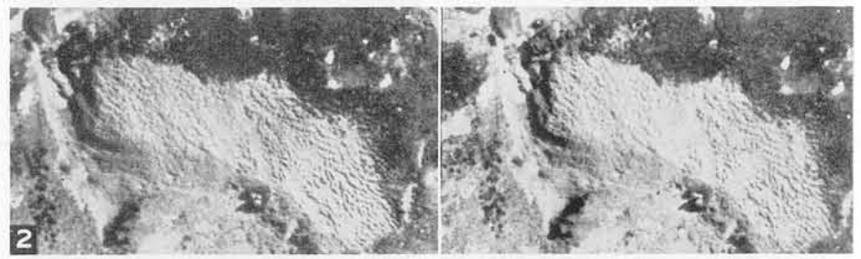


PLAN

1



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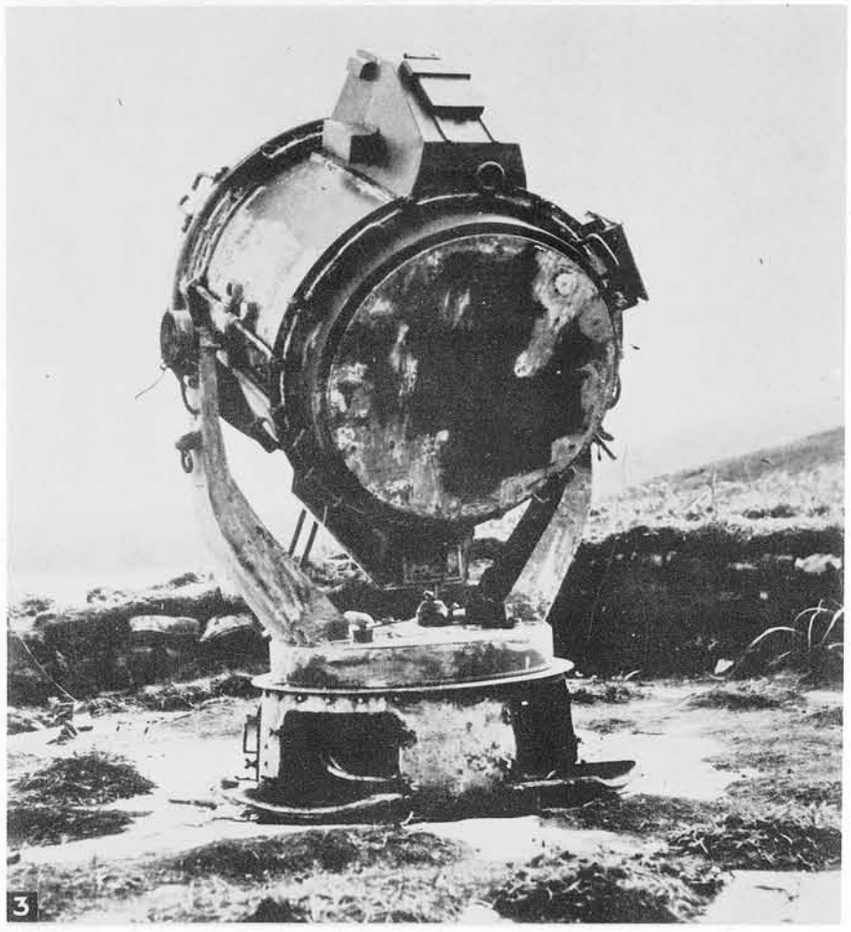
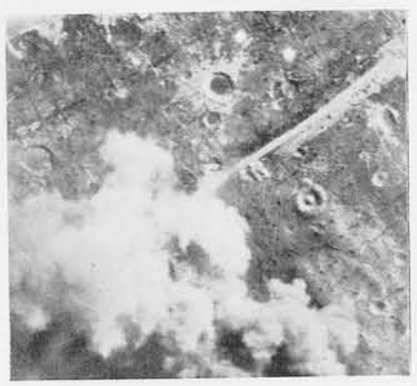


3

CONFIDENTIAL

SEARCHLIGHTS

CIRCULAR REVETMENTS



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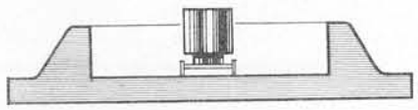
2



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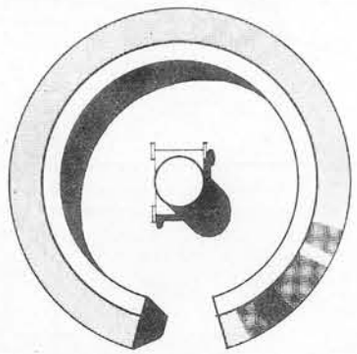


PLAN

1. BORAM, NEW GUINEA, 1:4000. Revetment with 30' diameter situated 500' from a 75 mm. AA battery. The roadside excavation could accommodate a generator truck.

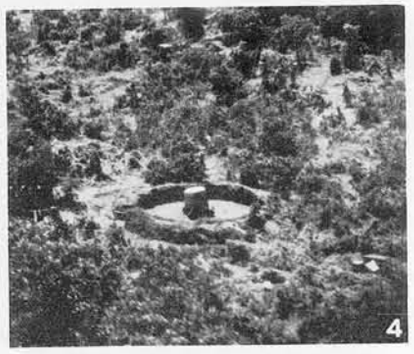
2. WEWAK, NEW GUINEA, 1:3250. Searchlight revetment with 26' diameter.

3. BORAM, NEW GUINEA, 1:6300. A stereo-pair of the camouflaged position shown in #5. The largest revetment contains the light; a saucer-shaped sound locator revetment is above and to the left of the light.

4. BUT DROME, NEW GUINEA, 1:600. An oblique view of a 150 cm. canvas-covered light in a 31' diameter position. Note the electric cables and the extended hand control.

5. BORAM, NEW GUINEA. A camouflaged position with palm fronds around the light and all revetments grass covered. The sound locator revetment is saucer-like in shape.

3



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5

SEARCHLIGHTS

CIRCULAR SOUND LOCATOR REVETMENTS

Sound locators become distinctive identification features when placed within saucer-like revetments. Usually the revetments are about 35' in diameter and located about 100' from the searchlight. A small revetment for the comparator should be found near the sound locator.

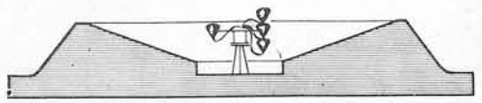
1. NANKING, CHINA, 1:5900. Saucer-like sound locator revetment located 90' from a double-wall searchlight revetment.

2. MATUPI ISLAND, An oblique view of a sound locator revetment in conjunction with a searchlight in a log structure. A comparator is in the tree.

3. KASHIWABARA WAN, PARAMUSHIRO ISLAND, 1:6000. Occupied and empty positions typical of searchlight stations in the Kashiwabara-Kataoka area. Inner diameters of searchlight and sound locators are 30' and 35', respectively. The revetments are 100' - 120' apart, connected by trail or communication trench.

4. KATAOKA, SHIMUSHU ISLAND, 1:10000. Occupied and empty positions. Note the shelter incorporated in the occupied searchlight revetment and the crews' quarters.

5. SAWAR, NEW GUINEA. The comparator would normally be contained in a small revetment near the sound locator; remaining small revetments would contain M.G. or automatic weapons.



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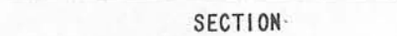
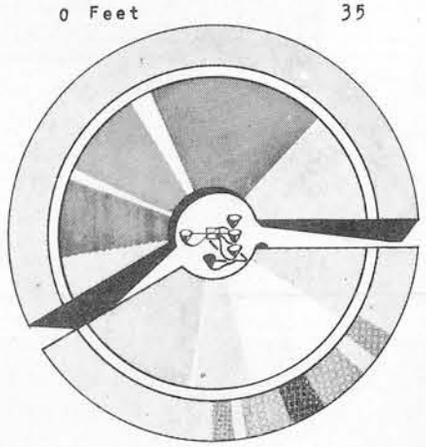
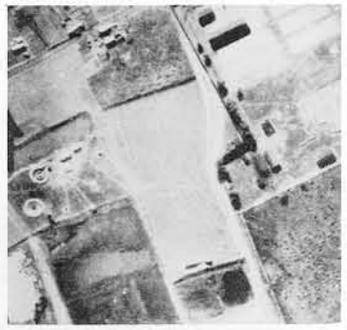
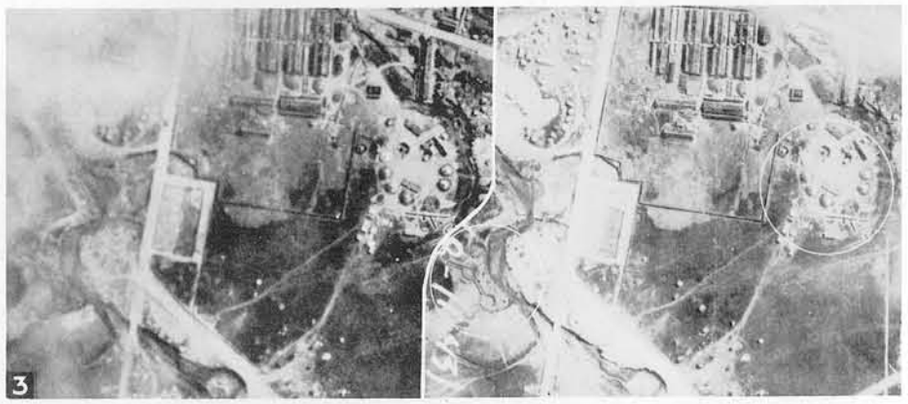
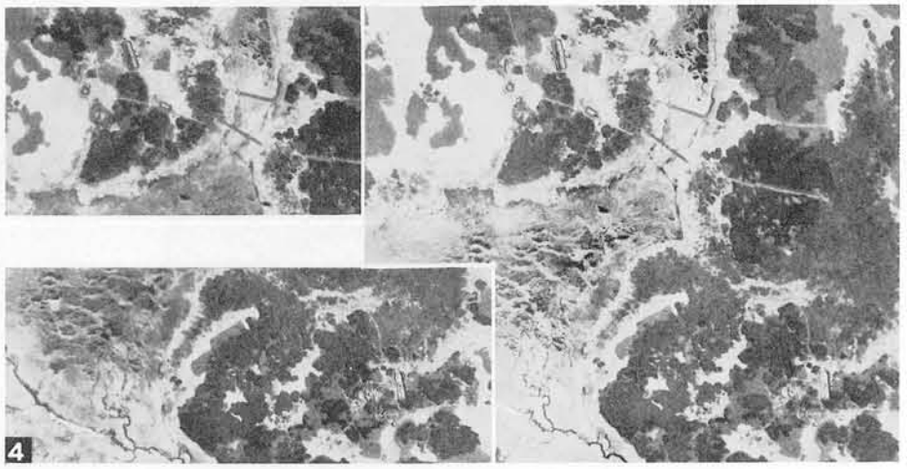


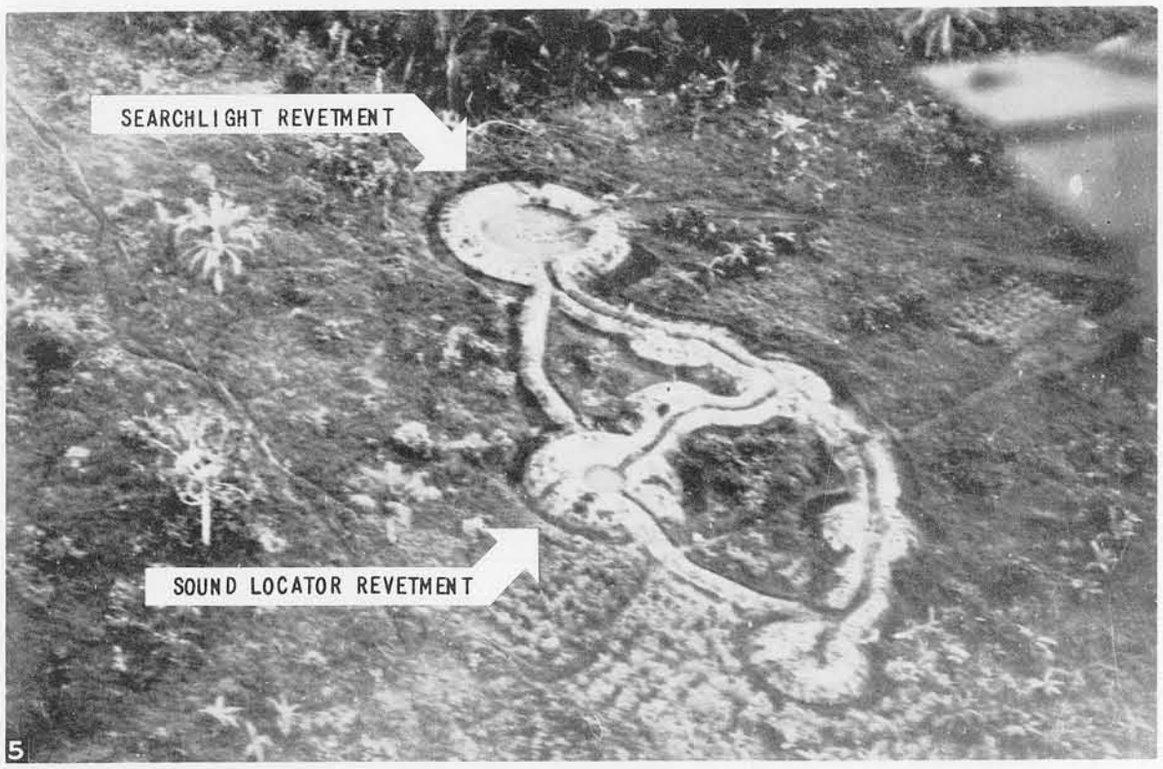


PLAN





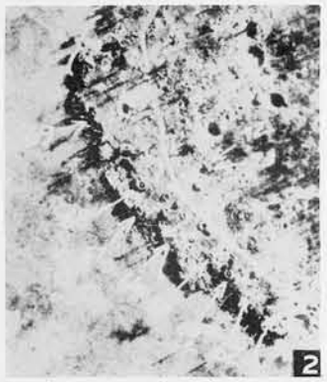




SEARCHLIGHTS

CIRCULAR REVETMENTS


1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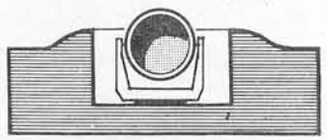
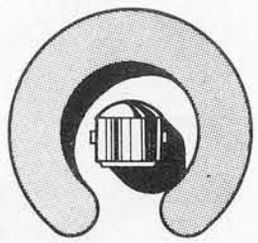


SECTION

0 Feet 8



PLAN

In the absence of characteristic searchlight shadow and as the diameter of the revetment decreases, it becomes increasingly difficult to distinguish between searchlight and automatic gun positions.

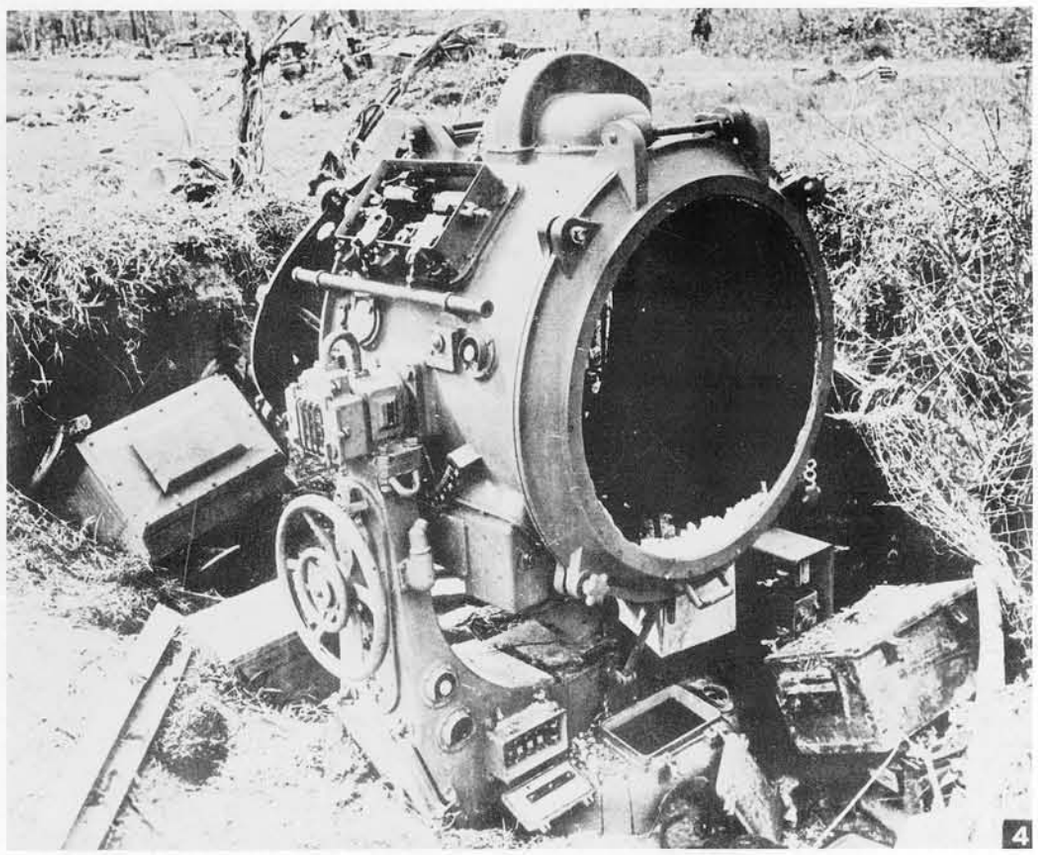
MUNDA POINT, NEW GEORGIA ISLAND.

1. A 60cm. searchlight emplaced in a rough, circular excavation 8' in diameter.

2. Stereo-pair of the lights shown in #1 and #2, including associated AA guns. The circled building was a powerhouse which supplied the search lights. Scale 1:4000

3. A 60 cm. searchlight in an 8' diameter revetment.

4. Closeup of #3 reveals the presence of a camouflage net.


4

SEARCHLIGHTS
DOUBLE-WALL REVETMENTS

Double-wall revetments provide for the manual operation of a searchlight with extended hand control; the outer circle is used as a walk by the operator; the inner space contains the light. From available examples, it is indicated that double-wall revetments contain mobile lights since the walls are provided passageways 6' to 10' wide.

1. FUTAMI KO, CHICHI JIMA, 1:8300. The path emanating from the double-walled revetment toward the point leads to a protective shelter for the light. A saucer-shaped sound locator revetment and a four-gun battery.

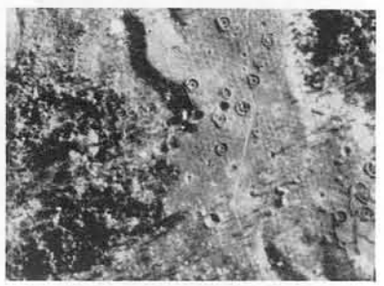
2. VILA, KOLOMBANGARA ISLAND, 1:10000. NOT SEARCHLIGHT POSITIONS BUT GUN POSITIONS. The two extreme right revetments with fire control post between contain 40 mm guns, and the remaining positions contain 25 mm and 13.2 mm guns. The outside revetments, 45'-65' in diameter, are to provide drainage; the inner revetments are 12'-15' in diameter. Note that the outer circle is not continuous and there is no provision for mobile equipment. Searchlights complement gun batteries, but are not themselves found in battery patterns.

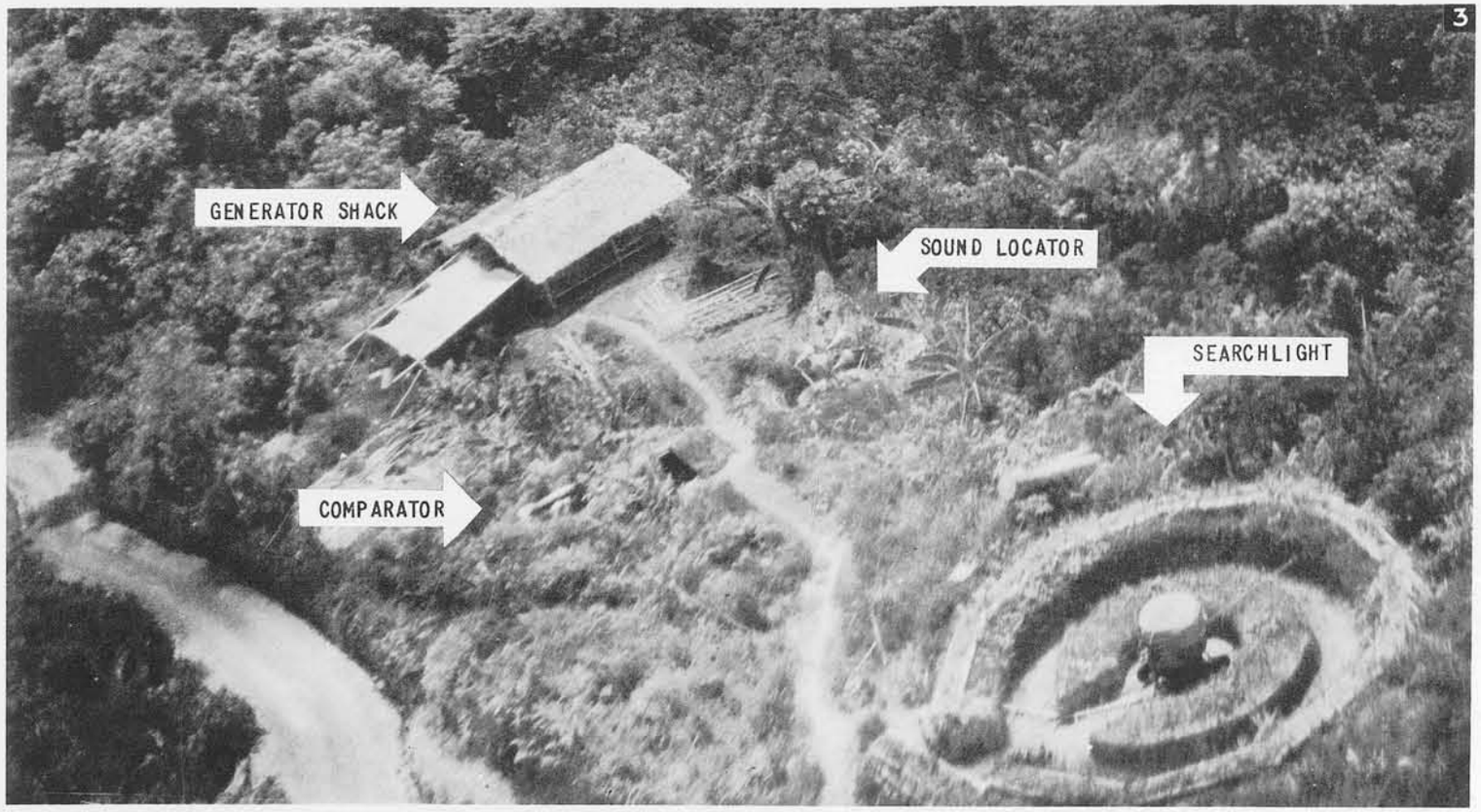
3. BORAM, NEW GUINEA. A 150 cm. mobile light with extended hand control. Outer and inner revetment are 33' and 12', respectively.

4. MINGALDON, BURMA. This double-walled searchlight position is one of seven around the aerodrome. Outer and inner walls are respectively 35' and 15' in diameter.


1


2





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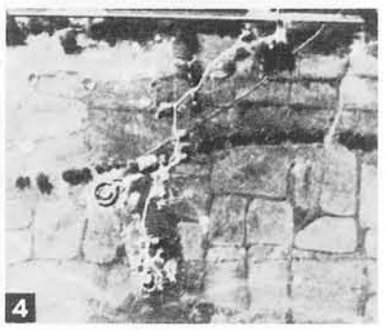
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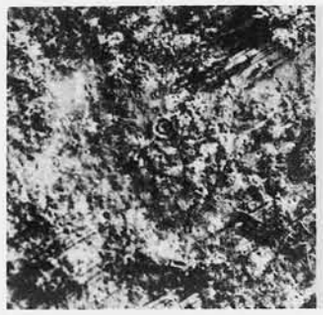
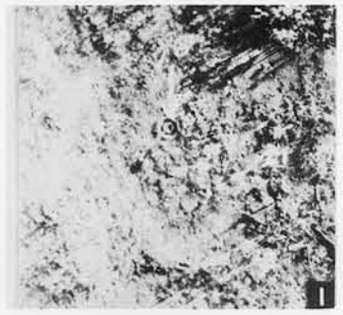
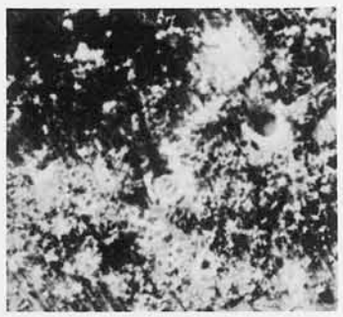
PLAN

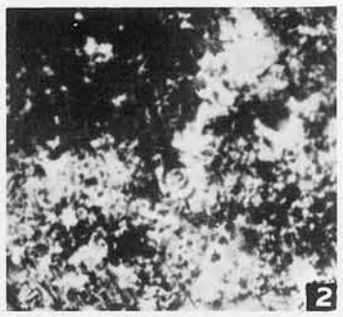
SEARCHLIGHTS

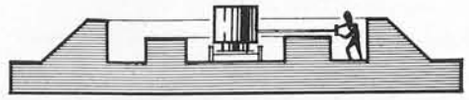
DOUBLE-WALL REVETMENTS



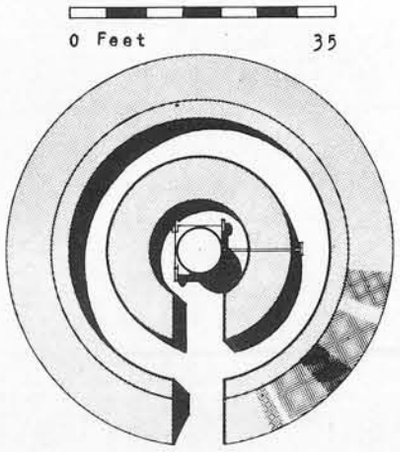








SECTION



PLAN

1. MUNDA POINT, NEW GEORGIA ISLAND, 1:5000. Outer and inner revetments measure 35' and 15' in diameter, respectively. A hideout for daylight concealment is 85' from the walled position.

2. MUNDA POINT, NEW GEORGIA ISLAND, 1:2800. A stereopair of the position shown in figure 5. The diameters of outer and inner revetments are 35' and 15', respectively. Roughness of outline is due to rock and coral blocks used in construction.

3. NANKING, CHINA, 1:5900. Double-walled searchlight revetment 90' from a 35' diameter sound locator revetment.

4. MUNDA POINT, NEW GEORGIA ISLAND. This ground shot shows the rough construction and materials.

5. MUNDA POINT, NEW GEORGIA ISLAND. A break (6'-7' wide) through the walls provides for movement of the light.

SEARCHLIGHTS
CIRCULAR PLATFORMS

Platform mounted lights are commonly used in conjunction with 127mm D.P. gun batteries. Detection and direction instruments for platform mounted lights have rarely been found; if this apparatus is installed in the fire control centers of related gun batteries, there is no definite proof of it.

Generator equipment is sometimes housed underneath the raised platform.

1. WAKE ISLAND, 1:6000. The circular searchlight platform is 500' from a 127mm gun battery.

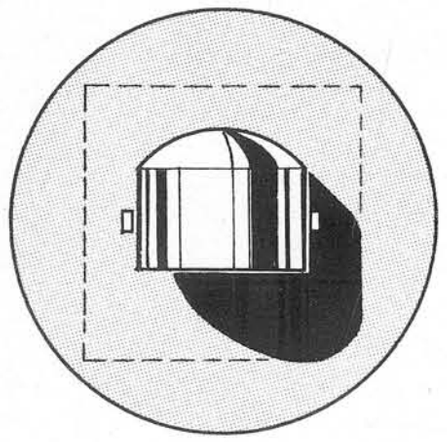
2. WAKE ISLAND, 1:1300. Shape and shadow identify this searchlight mounted on a raised circular platform about 12' in diameter. Notice the cable leading off to the right.

3. NAMUR ISLAND. A 150 cm. searchlight on a platform 12' in diameter and about 8' high. Steel framework is set in concrete. The space under the platform is enclosed by placing coconut logs against the steel framework.


1


2

0 Feet 12



PLAN


3

SEARCHLIGHTS

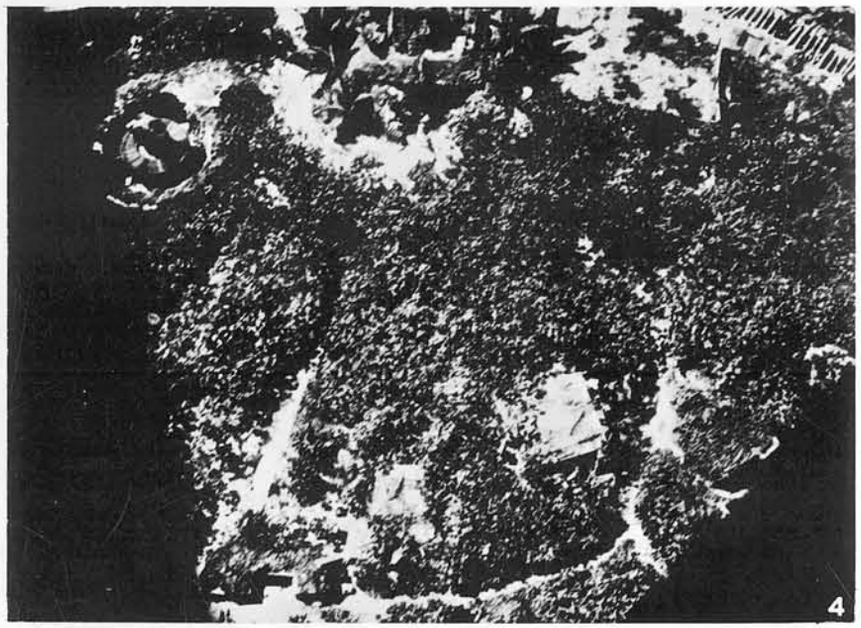
CIRCULAR PLATFORMS

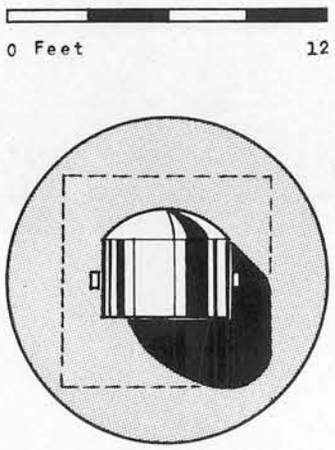
1. MILLE ISLAND, 1:4500. Stereo-pair showing the relationship of searchlights and 127mm gun battery. The lower light position is partially obscured by palm trees. Bombing has caused some obliteration.

2. WOTJE ISLAND. Canvas covered searchlight atop a circular platform. Typical of most island searchlight positions, this location commands a clear seaward sweep.

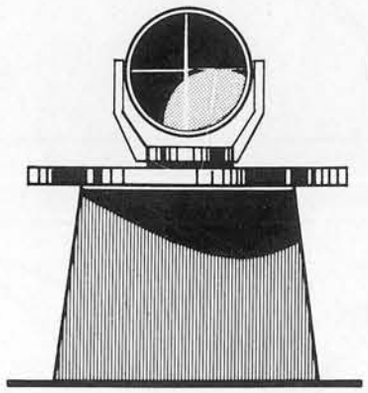
3. MILLE ISLAND. Canvas covered searchlights on either side of the island are mounted on circular platforms emplaced in "U" shaped revetments. Since ground surveys have shown generator equipment to be placed under some searchlight platforms, revments may indicate the presence of such equipment.

4. KWAJALEIN ISLAND. Canvas covered searchlight upon a revetted platform.





PLAN



ELEVATION

SEARCHLIGHTS

RAISED REVETMENTS—CIRCULAR AND RECTANGULAR

RABAUL, NEW BRITAIN

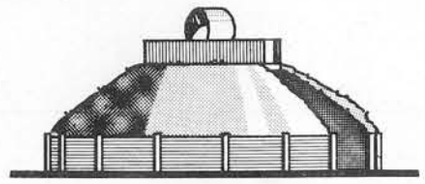
1. Stereo-pair (1:10000) of searchlights and 127mm gun battery on Sulphur Creek. The light tone of the lights is common, due either to canvas covers or high reflection from the rounded surfaces. Oblique views #2 and #3 show the 150cm lights to be within revetments built on rounded earth covered structures. Bombing has damaged gun revetments and fire control post.

2. Closeup (1:800) of the canvas covered light shows the revetment supported by a structure of logs covered with earth.

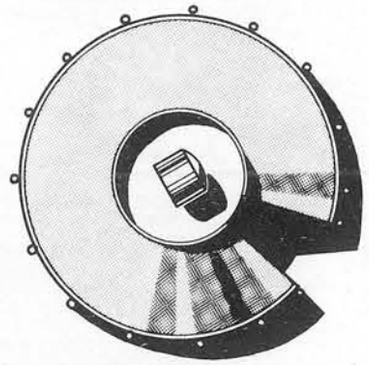
3. The entrance underneath searchlight "A" may indicate housing for generator equipment. "B" is shown in figure 2. "C" is the four-trumpet sound locator within a revetment. "D" houses the director. The gun battery is off the picture to the right.

4. WAKE ISLAND, 1:6000. These raised revetments are about 400' and 500' from the center of the 127mm gun battery. Differing from the Sulphur Creek lights, entrance is made over the surface of the mounds; and generators are likely housed in small buildings alongside the positions instead of being directly under the lights.

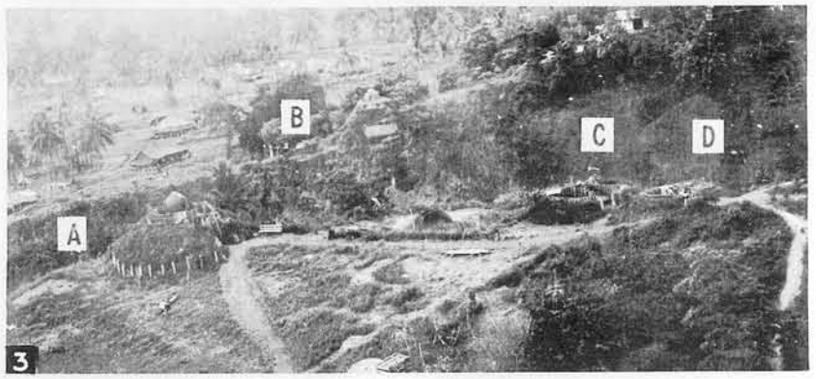
5. MATUPI ISLAND. The log structure forms a square revetment around the light. Sound locator is made apparent by the saucer-shaped revetment. A comparator is mounted in the tree between light and sound locator.

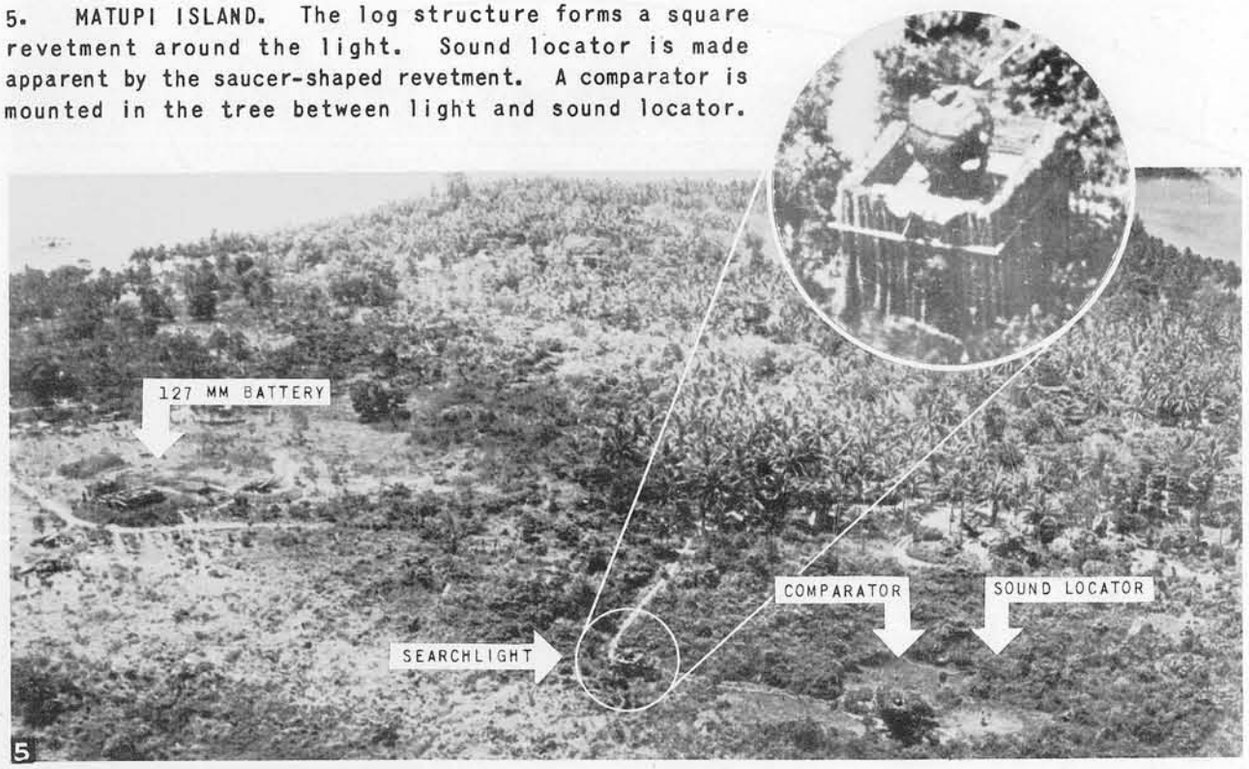


ELEVATION



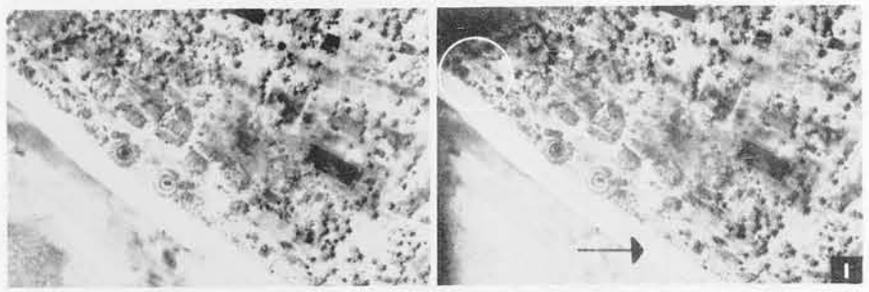
PLAN

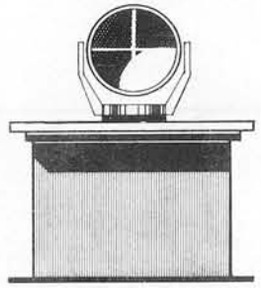




SEARCHLIGHTS

RECTANGULAR PLATFORMS





ELEVATION

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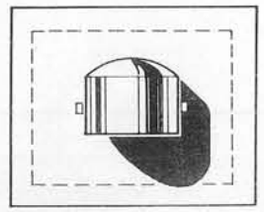


PLAN

BETIO ISLAND, TARAWA ATOLL

1. 1:4800. The circled installation is a 150 cm. searchlight mounted upon a rectangular concrete building 300' from a 127 mm. AA battery. To the lower right is a searchlight atop a circular platform.

2. Another example of a searchlight mounted atop a concrete building. Note the 127 mm. AA battery.

3. Low oblique of the structure in #5.

4. SAIPAN ISLAND. A rectangular wooden platform supporting a searchlight (estimated to be 110 cm). Dummy installations similar to this were also found.

5. BETIO ISLAND. This 150 cm. searchlight is mounted on top of a 10' x 12' x 8' reinforced concrete building containing generator equipment.

SEARCHLIGHTS

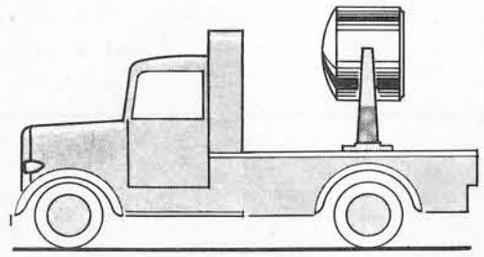
TRUCK MOUNTED LIGHTS AND NON-REVETTED POSITIONS

1. VILA, KOLOMBANGARA ISLAND. Non-revetted searchlights in a plantation. The obstruction of the beam by trees is occasionally disregarded.

2. WAKE ISLAND. A mobile searchlight located in a shallow ditched area off the main road. Wheel tracks and cylindrical shape of the light are the only clues to identification.

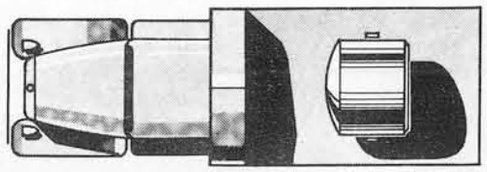
3. VILA, KOLOMBANGARA ISLAND. An additional pair of non-revetted 150 cm. searchlights.

4. BETIO ISLAND, TARAWA ATOLL. This 98 cm. searchlight truck represents standard equipment that has also been taken on Saipan, Peleliu, Lae-New Guinea, and Little Kiska Island. Small size and ease of movement make this light practically impossible to detect. Power for operation of the light is supplied by a built-in generator run by the truck engine. On Little Kiska, the searchlight truck was dug in, camouflaged with nets, and gave the appearance of a small building; on Saipan trucks were housed in underground concrete garages.



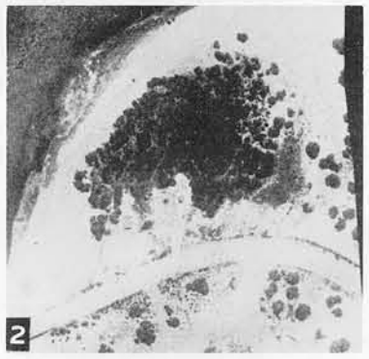
ELEVATION

0 Feet 18



PLAN

1



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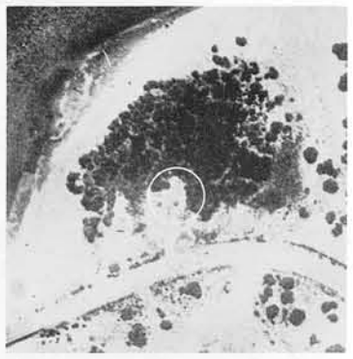

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4

CONFIDENTIAL

SEARCHLIGHTS

RELATIONSHIP OF GUNS AND SEARCHLIGHTS

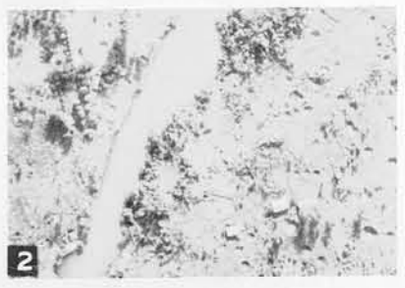

1

It is common to find two 150cm searchlights within a 500' radius of a 127mm twin-mount D.P. gun battery; occasionally only one light may accompany a battery.

1. MILLE ISLAND. Searchlights, on circular platforms, are on either side of the island and within a 330' radius of the battery.

2. RABAUL, NEW BRITAIN 1:7500. Stereo-pair of #3. Fire control center for the 127mm battery has been virtually bombed out.

3. A low oblique reveals sound locator and director revetments. One searchlight is obscured by the phosphorus bomb burst at the top of the picture; one gun is off the photo to the right.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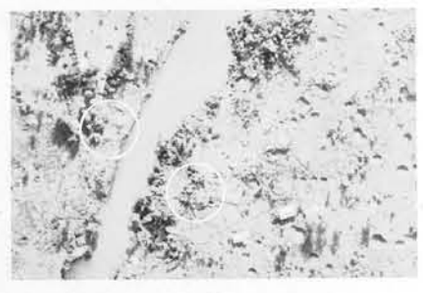
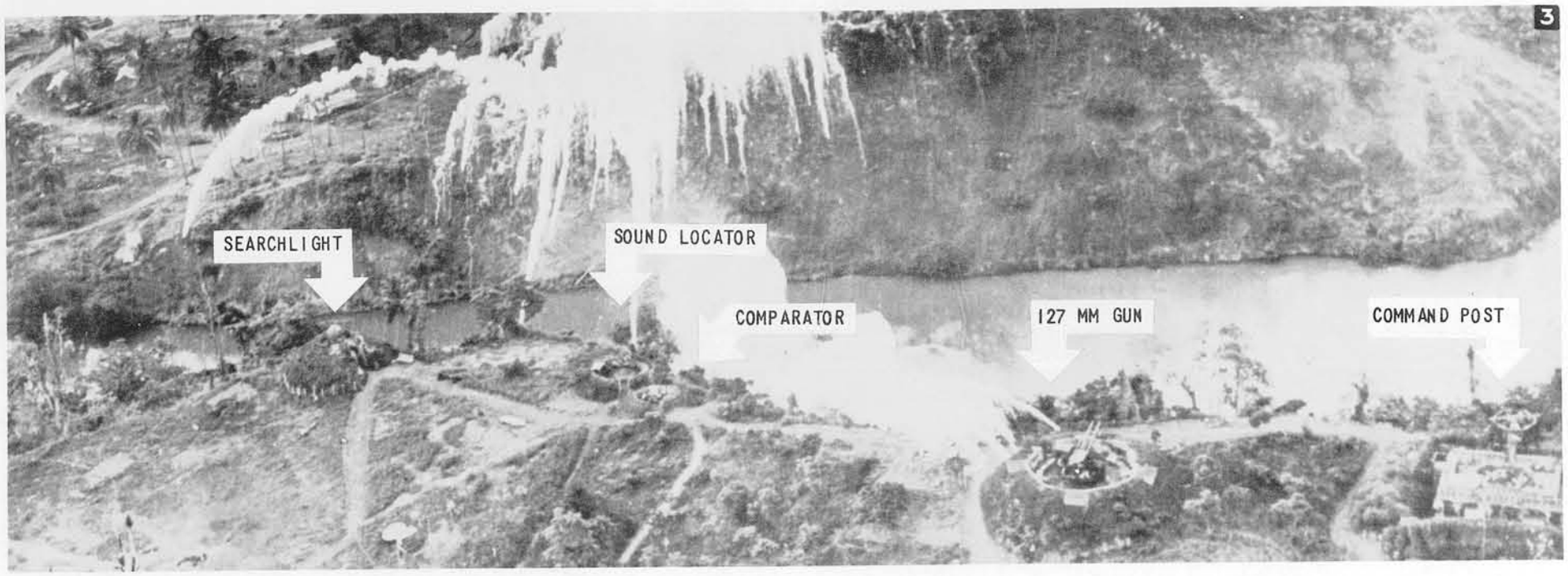




3

SEARCHLIGHTS

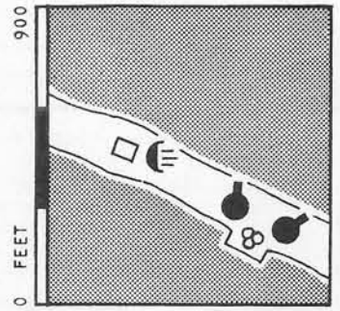
RELATIONSHIP OF GUNS AND SEARCHLIGHTS

1. JALUIT ISLAND, 1:6500. One searchlight on a circular platform is 250' from the closest 127mm gun revetment. Note that the light is nearly white in tone.

2. VANAKANU, NEW BRITAIN, 1:6500. Searchlights are emplaced on either side of the gun battery, one in a raised revetment, the other in a square structure.

3. MILLE ISLAND, 1:3000. Stereo-pair of #4. Palm trees surrounding searchlights are a common occurrence. Only a part of the fire control center appears on the left between the guns.

4. MILLE ISLAND. Circular platforms are emplaced in 16' diameter revetments, bearing evidence to the housing of generator equipment beneath the platform. No searchlight director or detector is evident.

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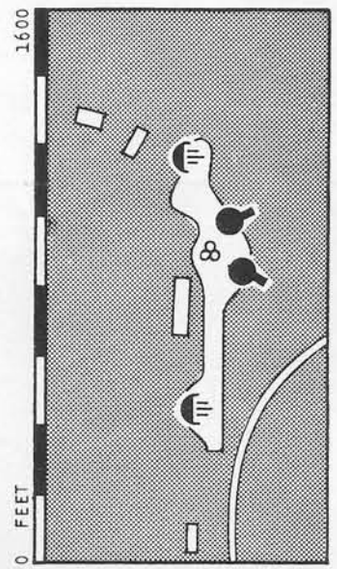


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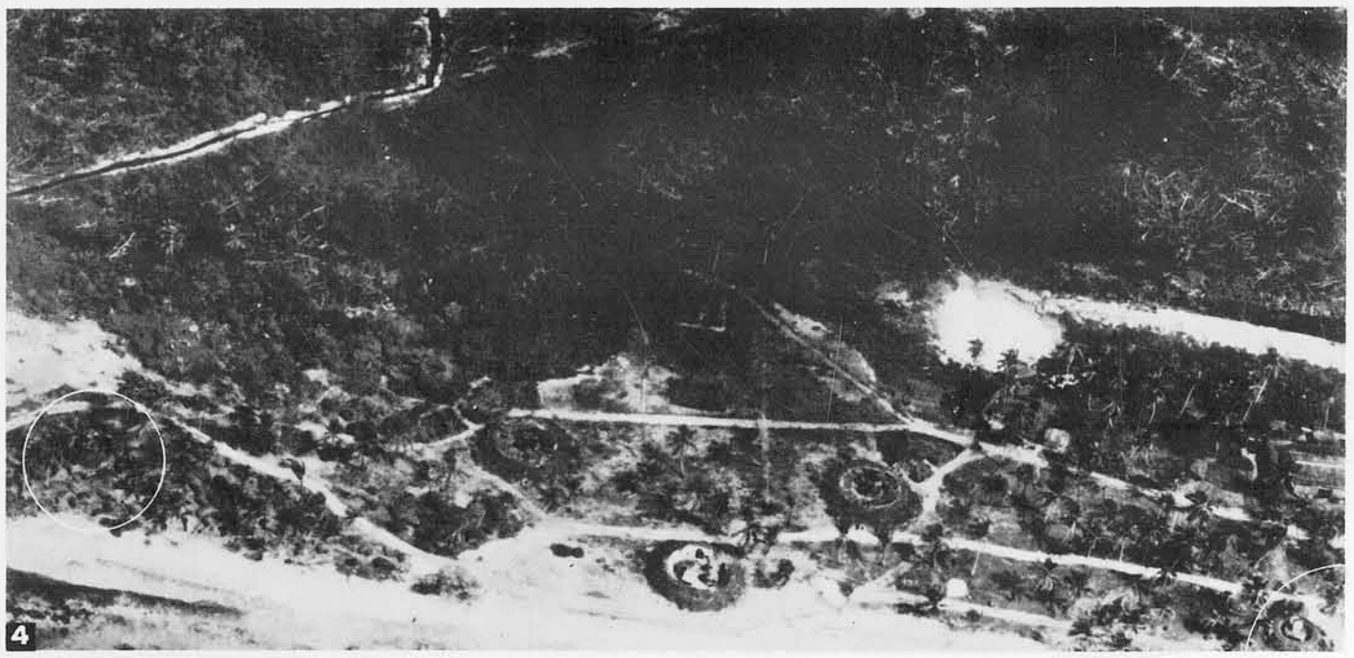
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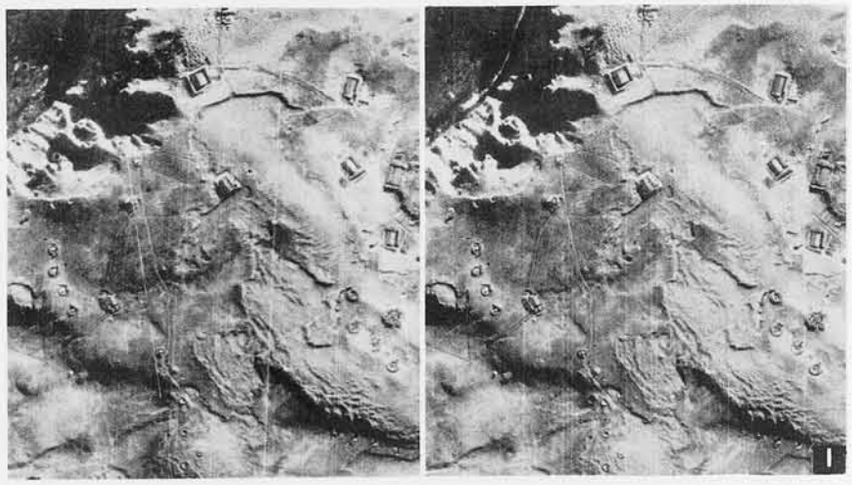
3

SEARCHLIGHTS

RELATIONSHIP OF GUNS AND SEARCHLIGHTS



Where coast defense and AA gun batteries have been found close together, searchlights have generally been placed to accommodate both. On flat coral islands, lights have most often been placed upon raised platforms along island perimeters, or upon points of land. On topography with hills or promontories, lights are placed to take advantage of such elevations. Such locations attest to the use of searchlights with coast defense guns.

1. NORTH HEAD, KISKA ISLAND, 1:7000. Two 150 cm. fixed searchlights emplaced between a 4.7" C.D. and a 75 mm. AA battery. The lights are within 450' of the C.D. battery and within 900' of the AA battery.

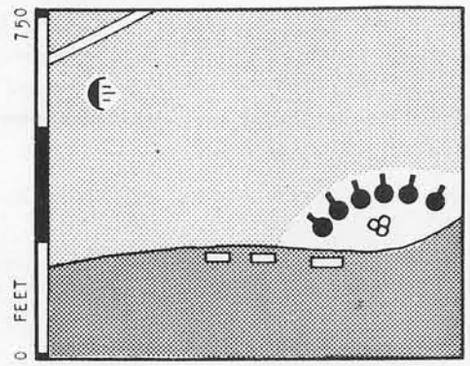
2. WAKE ISLAND. Two searchlights located between a 127 mm. D.P. and an 8" C.D. gun battery. One light is atop a high conical tower, while the other is mounted on a raised circular platform.

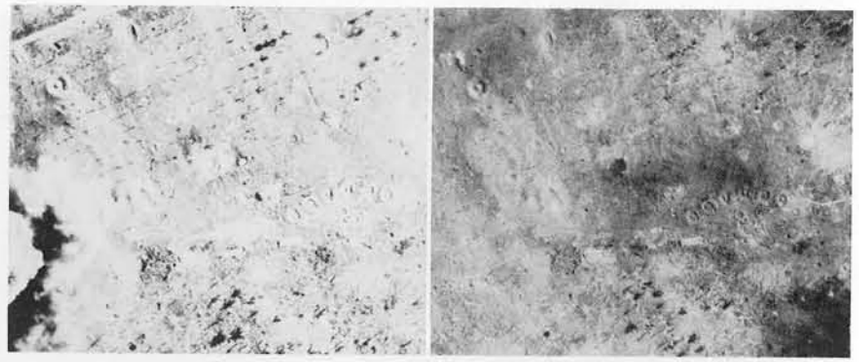
3. NORTH HEAD, KISKA ISLAND. A low altitude vertical of #1 showing the 4.7" C.D. battery and the 150 cm. searchlights on either side.

SEARCHLIGHTS

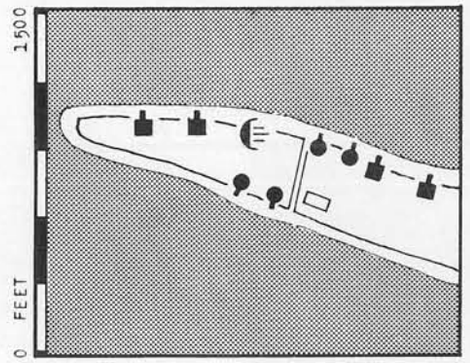
RELATIONSHIP OF GUNS AND SEARCHLIGHTS

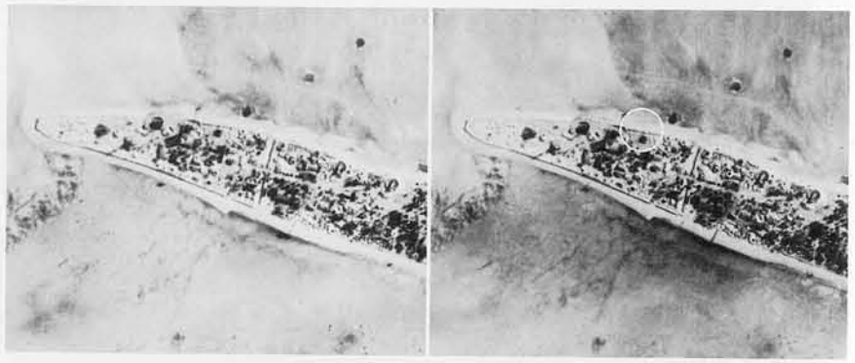
1. BORAM, NEW GUINEA, 1:5000. A searchlight in a circular revetment is 500' from a 6-gun 75mm. AA battery. The gun battery is situated on a ridge above the BORAM AIRFIELD.



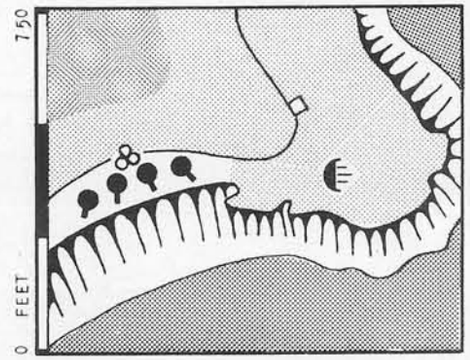


2. BETIO ISLAND, 1:10,000. A searchlight atop a rectangular structure is in such a location to be used with both 8" C.D. and 75mm. AA batteries.

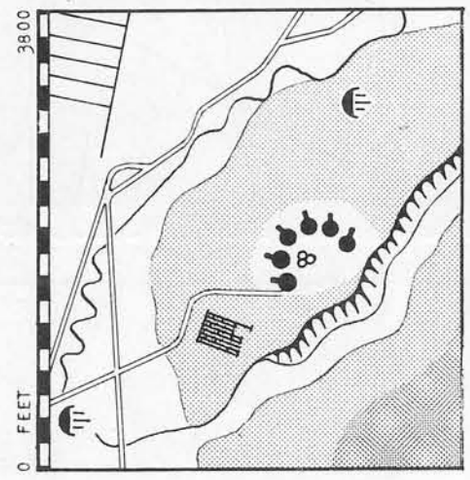


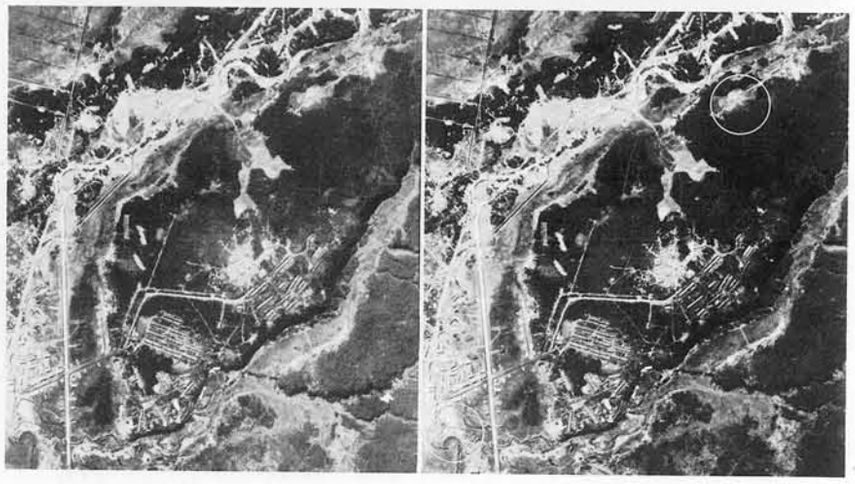


3. CHICHI JIMA, 1:5000. Double-wall searchlight and saucer-shaped sound locator revetments on the point are 450' from the fire control center of the 4-gun AA battery.



4. KASHIWABARA WAN, PARAMUSHIRO ISLAND, 1:18500. Two searchlights in circular revetments with associated sound locator revetments are within a 590' radius of the 6-gun 75mm. AA battery on top of the hill.





SEARCHLIGHTS
CAMOUFLAGE


1

The Japanese use of camouflage on searchlight positions is largely confined to natural cover or some method incorporating natural material. Effective blending with the surroundings will make a searchlight difficult, if not impossible, to detect.

1. PONAPE ISLAND. Palm fronds surround this canvas covered light in a raised revetment. Matting with leaves and fronds cover a 3-gun coast defense battery. A range finder may be seen in the center of the photograph.

2. MUNDA POINT, NEW GEORGIA ISLAND. A double-walled revetment covered with vines. Brush surrounds the position.

3. BORAM, NEW GUINEA. Palm fronds are leaned up against the light, and all revetments are covered with a coarse creeping grass.

4. BORAM, NEW GUINEA. A canvas covered mobile light is emplaced in an excavation under thick brush. Track activity should be noted in a vertical photograph, but the light is effectively covered.


2


3


4

SEARCHLIGHTS
CAMOUFLAGE

1. DAGUA, NEW GUINEA. A sound locator within a revetment covered by a pole frame. There is no attempt to cover the 150cm. light.

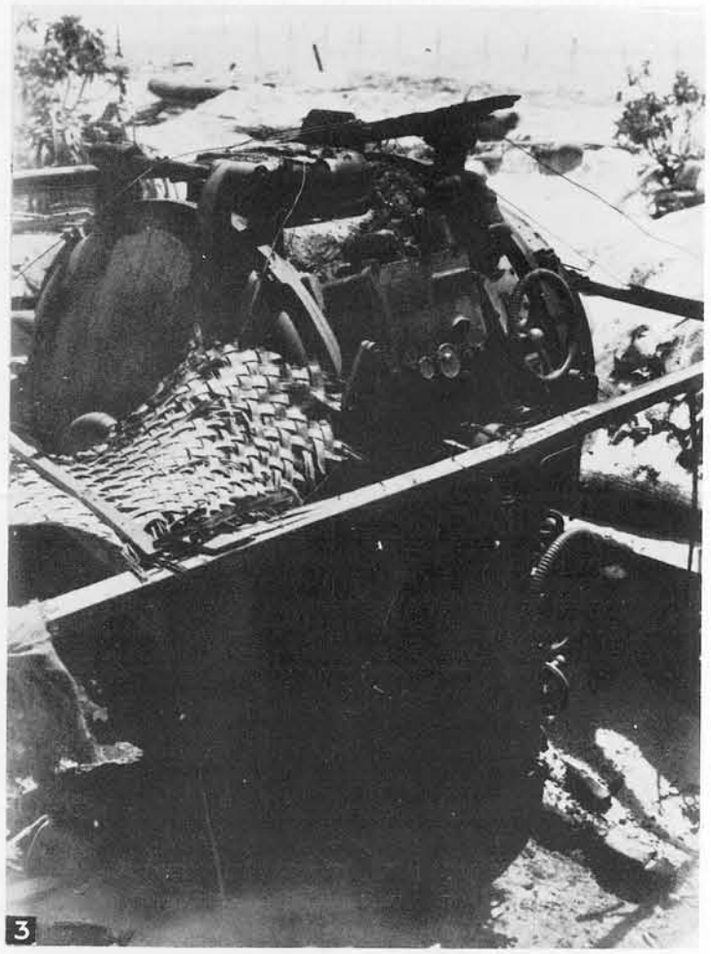
2. SAIPAN ISLAND. This dummy closely resembles an actual searchlight, and was placed in a logical relationship with a dummy coast defense battery.

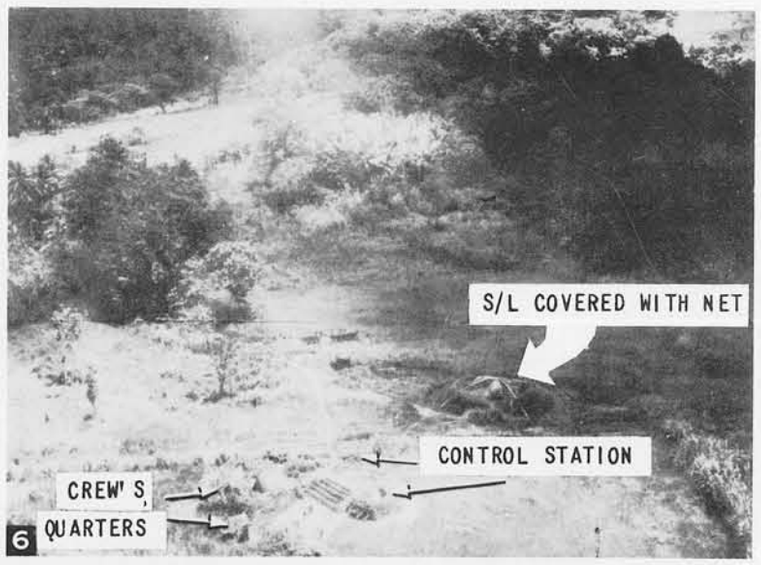
3. BETIO ISLAND, TARAWA. Pandanus matting upon a wire and wood frame. This covering would effectively alter the characteristic round shape of the searchlight. Identification might be made upon the basis of relationship with an adjacent gun battery.

4. LITTLE KISKA ISLAND. This searchlight truck was dug in and net-covered. Tundra vegetation was woven into the netting. On aerial photographs the installation had the appearance of a small revetted building.

5. HOLLANDIA, NEW GUINEA. Vertical view of #6.

6. HOLLANDIA, NEW GUINEA. Oblique photograph of a net-covered position, the net being held in place by two crossed poles. The searchlight can be seen. Revetments and quarters are sod-covered.

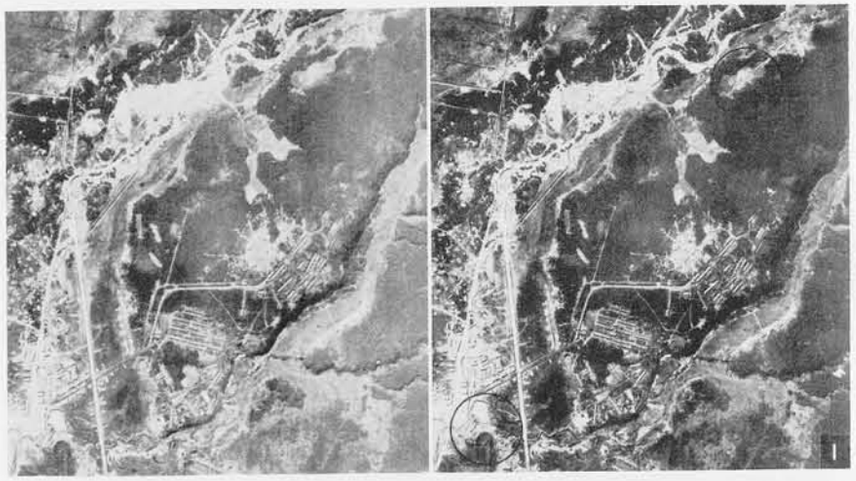




CONFIDENTIAL

SEARCHLIGHTS

NIGHT PHOTOGRAPHY INTERPRETATION



Searchlights on night photographs will appear as light discs or as tracks, depending upon whether the film is exposed instantaneously or for a period of seconds.

If an "open plate" exposure is made, the camera shutter remains open for some seconds, during which time the photo flash explodes. In such an exposure, the searchlight bowl, which is a fixed point on the ground, produces a track (or hem) like any other light or fire which varies only by the movement of the aircraft carrying the camera. The beam, on the other hand, which is caused by the transmission of the light through the atmosphere, varies according to the operation of the searchlight. The beam (or curtain) is often seen on night photos in fine thin lines at a sharp angle to the bowl track. The intensity of the beam varies directly with amount of water or other material suspended in the atmosphere. When the photographic aircraft is held in the searchlight, the beam will be absent.

If an instantaneous exposure is made and the camera shutter is tripped by a photo-electric cell at the moment of the flashbomb explosion, a searchlight will appear as a light spot in its correct ground location.

From "open plate" photographs, the method of locating the ground position of a searchlight is similar to that for fires. One difference is that a searchlight track may appear complete (beginning and ending within the limits of one frame) when actually the light can be extinguished voluntarily, producing a track that appears complete but is not.

Using one night photograph, the position may be located by referring a complete track and ground detail to a day photograph. Using two night photographs, one with a complete track, the ground detail of one film is superimposed upon that of the other, and the intersection of the tracks indicates the correct location of the searchlight. Again differing from fires, searchlights may be plotted by the intersection of tracks on photographs taken different nights.

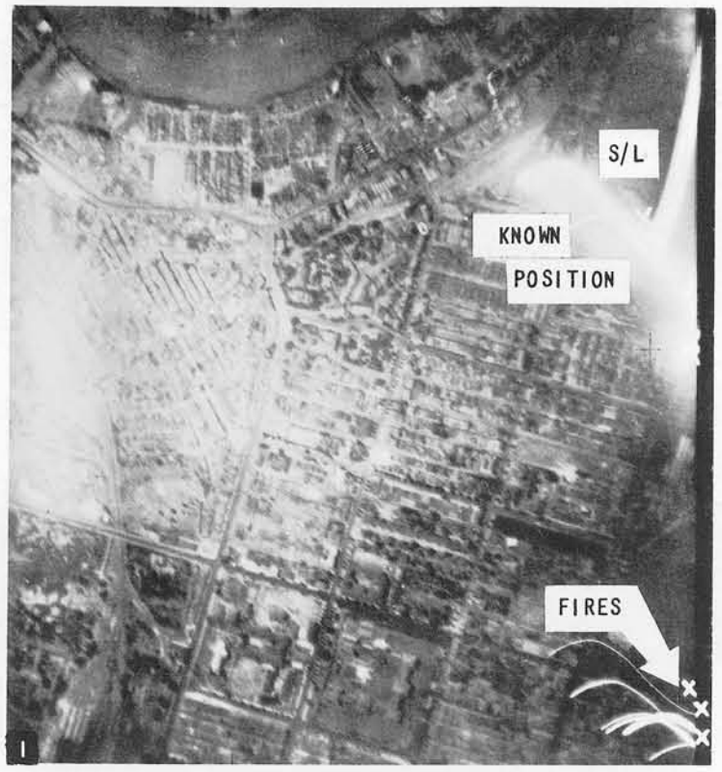
1. KASHIWABARA WAN, PARAMUSHIRO ISLAND - 1:18500. A daylight photograph showing searchlight and heavy AA positions seen in #2, a night photograph. These searchlights were originally detected from daylight photographs and were confirmed by night photographs.

2. KASHIWABARA WAN, PARAMUSHIRO ISLAND. An instantaneous night exposure showing two searchlights, the lower light directly engaging the aircraft. The lower light might be mistaken for the photoflash, but the shadows indicate that the flash was off the photograph to the left.

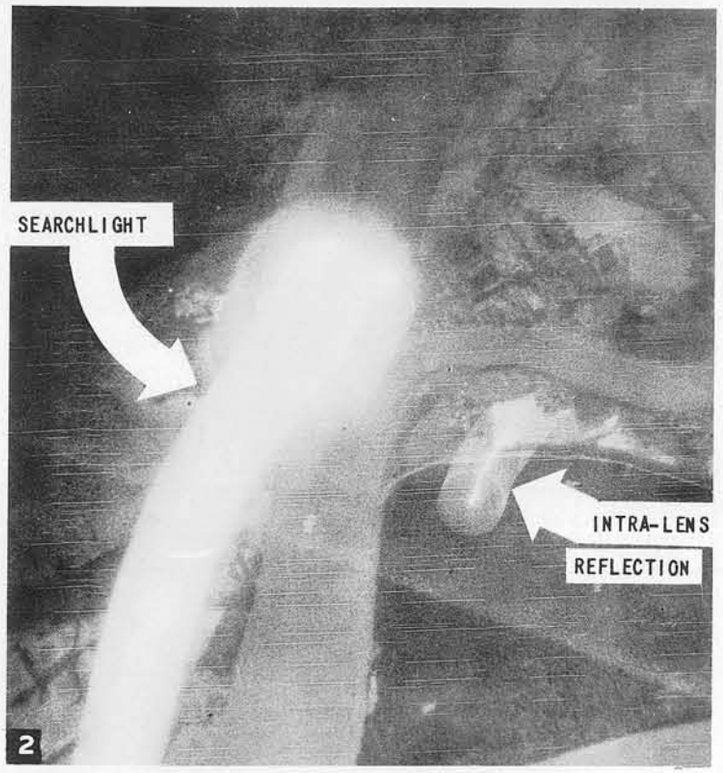
3. RANGOON, BURMA. A complete searchlight track at Malagon Yards. The ground location of the light is obtained by referring to daylight coverage (#4).

4. RANGOON, BURMA. Daylight photograph showing a searchlight and sound locator revetments at Malagon Yards.

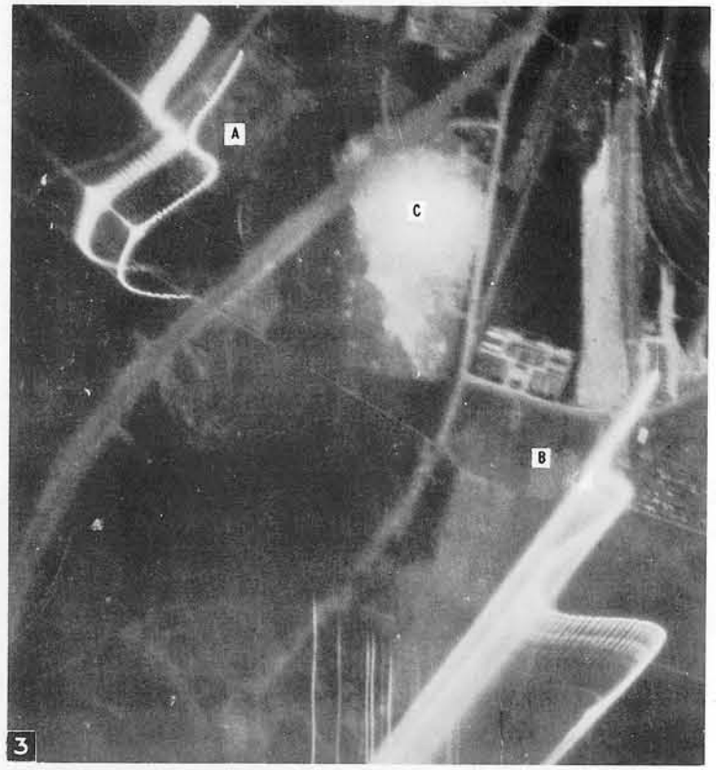
1. DUFFERIN GARDENS, RANGOON, BURMA. A searchlight track can be used to pinpoint fires when the position of the searchlight itself is known. The position of the searchlight on its track is known and is marked with a cross. The fires at the bottom right are presumed to be located at corresponding points on their tracks. Usually it is necessary for the respective tracks to be complete for this deduction to be made, but in this case, subsequent day cover proved that fires had been burning at the points indicated. Conversely, a searchlight may be located if a fire is pinpointed by a smoke plume along its track.



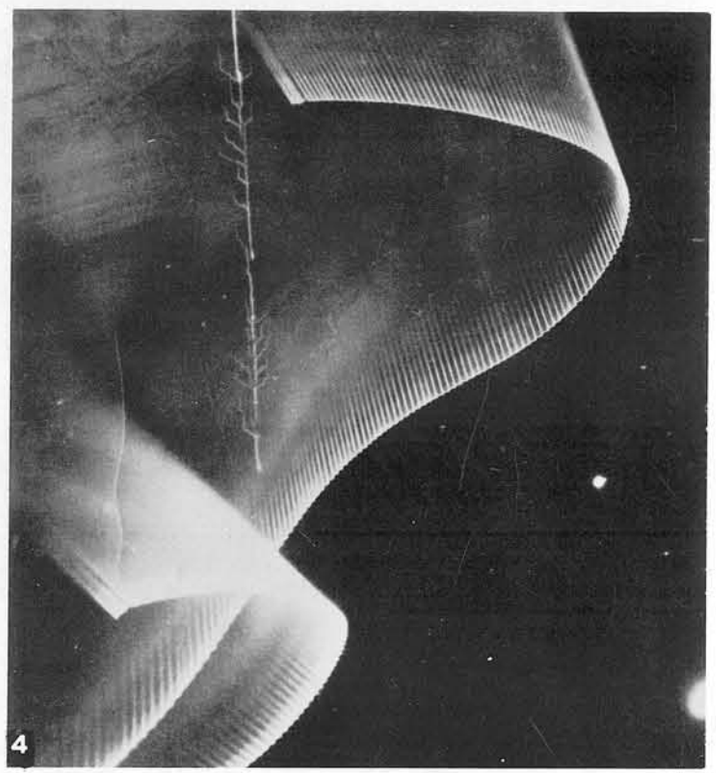
2. RANGOON, BURMA. A searchlight was focused on the aircraft at the time of photography. Sharp evasive action taken by the aircraft is indicated by the track running off the picture at right angles to the line of flight. The oblong shaped halation is caused by intralens reflection of the searchlight directed into the camera lens. No beam is visible since it has become merged with the bowl track.



3. NURNBURG, GERMANY. "A" and "B" show the curtain effect of the searchlight beam. Since the track of "A" is shorter than that of "B", searchlight "A" must not have been in operation during the total exposure time of the film. "C" is the muzzle blast of a heavy AA battery. Compare this muzzle blast to the effect of the searchlight in #2, page 8.22.



4. BERLIN, GERMANY. Two incomplete searchlight tracks. The clarity and uniform fading of the curtain indicates a uniform condition of haze on mist. Oscillation of the bowl track is due to vibration of the aircraft.



SEARCHLIGHTS

OPERATIVE CHARACTERISTICS OF SEARCHLIGHTS

The principal elements external to the searchlight which affect it's efficiency and performance are:

1. The distance from searchlight to target.
2. The absorption of the atmosphere.
3. The dimension and characteristics of the target.

1. The distance from searchlight to target.

The illumination on the target is inversely proportional to the square of the distance to the target. When a certain point in height is reached the eye no longer perceives the dimensions of the object as it sees nothing more than a luminous point.

2. The absorption of the atmosphere.

Atmospheric conditions are of primary importance in the transmission of light. As the atmosphere is clear or misty, small or large light losses are encountered in traversing the distance between searchlight and target or the distance between the target and the observer's eye.

3. Dimensions and characteristics of the target.

The visibility of the target is affected by many factors among which are:

a. The size and angular presentation of the target.
b. The reflecting or diffusing power of the target.
c. The color of the target.
d. The effect of color and illumination contrast between the target and its background.
e. The effect of relative illumination of the field of view.

3a The size and angular presentation of the target.

While the dimensions of planes have increased, bombing heights are likewise greater, the latter factor being of greater consequence. The maximum projected area of the plane in flight will occur when the plane is directly overhead in the beam; and the projected area will decrease approximately 30% when the plane is low and viewed directly ahead. Thus, as the angle is decreased from 90^{o} to 0^{o} the visible surface area is diminished 30%.

Mist is an almost impenetrable screen for a seerchlight beam, while a rain curtain can be easily penetrated. Dust also tends to reduce the amount of light transmitted. Atmospheric absorption consists fundamentally of two elements, light scattering and true absorption. Violet and blue portions of the spectrum of the beam are scattered more strongly than other colors thereby accounting for the characteristic blue tone of the searchlight beam. A considerable part of the scattered light comes back toward the searchlight and the observer. Scattered light also acts to form a screen surrounding the target. True absorption of the shorter wave length portion of the spectrum is greater than that of longer wave lengths, accounting for the variation in the color of beams when analyzed from different distances from the light source. Amber and red colors predominate at the greater distances. The total absorption of the atmosphere will vary from 5% per kilometer for very clear weather to almost total absorption in fog. When measured, the absorption is also found to vary greatly for different geographical locations, seasons of the year, and altitudes.

3b Reflecting or diffusing power of the target.

Certain objects on the target may possess parts having a brilliancy which reflect the light in the direction of the observer's eye. Polished or bright surfaces on the plane should therefore be avoided or covered.

3c Color of the target.

Light objects have a highly reflective power while dark objects are very absorbent. The use of dark or black, soft textured paint will reduce the reflective property of a plane to a small fraction of that of its normal covering.

3d Effect of color and illumination contrast between the target and its background:

The color and illumination of the target with respect to it's background gives rise to an effect of contrast which greatly influences visibility. A light target on a dark background or a dark target on a light background will be more easily distinguishable than if the tints of the two are more or less similar or the degrees of illumination are comparable.

3e The effect of relative illumination on the field of view:

For visibility of near objects, a difference of only a few percent in illumination of the object and its background is necessary while for distant objects, a contrast in brightness between them and the background must be very great. Investigations have shown that, whereas a ratio of contrast in brightness of 2:1 between the target and the background is sufficient for visibility of a bombing plane a few thousand yards from the searchlight, a ratio in excess of 10:1 will be required for a distance of 10,000 yards.

Background for the beam itself also affects the relative illumination. Maximum ranges are secured on dark black nights whereas moonlight will lower the range.

[redacted]

Searchlights are used independently of flak for several purposes:

1. To indicate to night fighters the track of attacking planes.

2. To illuminate and silhouette planes so that night fighters can see them more easily.

3. To dazzle bomber crews so that they cannot see targets or fighters.

4. To hide targets by concentrating a cone of light over them.

5. To counteract the effect of parachute flares by placing a cone of light under them.

6. To act as homing lights for friendly aircraft.

A single searchlight might indicate the track of a bomber by pointing at it vertically and then moving horizontally in the direction of its course. It may also focus on a point in advance of the bombers estimated course, and perhaps wave in the direction of flight. Circles are described around the plane to indicate its presence and track and to invite other individually controlled searchlights to focus on it until it can be transferred to a cone of lights. Successive pairs of lights, directed one on each side of the plane and forming a lane, may indicate the path of the bomber. Sometimes a wall of light may be formed to silhouette the attacking plane for night fighters. The projection of light beams on a cloud below the aircraft will silhouette it to overhead fighters; a cone may be used similarly as a background.

The terms "dazzle" and "glare" are often confused with one another. Dazzle is the direct blinding effect of the powerful rays, glare is the light interposed between observer and target in such a way that the target is obscured.

The following are inferences drawn from searchlight trials and experience:

(a) Dazzle does not occur unless the aircraft is directly illuminated by one or more beams.

(b) A single beam will not produce the effect except at fairly short range.

(c) A concentration of several beams can cause acute difficulty to pilot or bombardier.

(d) Head on illumination causes far more difficulty to aircraft then does illumination from abeam or astern.

(e) Short range engagement of enemy aircraft by searchlights has apparently caused pilots to lose control and crash.

Dazzle or glare effect is most pronounced between 2000 and 4000 feet and is effective up to 15000 feet. Dazzle or glare at altitudes even exceeding 10000 feet have been known to blind pilots and to make location of target difficult and accuracy of bombing poor. Night adaption of eyes is impaired. The glare effect of a searchlight trained upon a low-flying aircraft is great and it makes low-flying attacks hazardous. Glare effect does not noticeably interfere with crews of aircraft not directly in the beam.

Dazzle effect of a searchlight beam is greater in a haze than in clear weather. The Germans use lights to sweep horizontally to dazzle crews, making it difficult to see the target.

Glare can also be very effective when there is considerable ground or industrial haze, the beam of light is projected to a low angle of elevation into the haze, producing a pool of light over the target thus making identification difficult.

Searchlights are also used as a homing device for aircraft. They may be colored and are operated to conform with prearranged signals.

German A A defenses rely mainly on unseen methods of fire control but augment their fire by visually controlled guns using searchlights only when there is little or no cloud cover. Among aircraft coned by lights for more than 20 seconds (and therefore probably engaged visually), the percentage damaged has been about twice as high as among planes illuminated for a shorter period. Evidence did not indicate that those coned for more than 20 seconds were subjected to more intense A A fire than the others. The risk of being illuminated seemed to be about the same at bombing altitudes of 6000 to 20000 feet. On one occasion when conditions were favorable for searchlights, 70 to 80 bombers over a target were effectively coned (i.e. for more than 20 seconds) at the rate of about one per minute.

Heavy A A fire in coordination with searchlight cones is extremely accurate and destructive. Once the cone centers on a plane, it ignores all other aircraft and proceeds methodically to direct the destruction of the one it has caught.

Japanese Use of The Master Light.

Several areas have reported the use of the Control or Master Searchlight System by the Japanese. The Master Searchlight is distinguishable from the group of lights, for which it acts as a guide, by the bluish tinge of its beam. When the sound or radar controlled Master Light engages the target, a concentration or cone of lights centers on the blue light and moves with it. (If the other lights in the group do not immediately expose and illuminate the plane they can often be avoided by an immediate change in course and speed). According to P.O.W. reports, the blue tinge of the Master Light is caused by a colored mirror plate attached to the searchlight lens.

[redacted]